APRIL 1974

rsc

RAILWAY SYSTEM CONTROLS

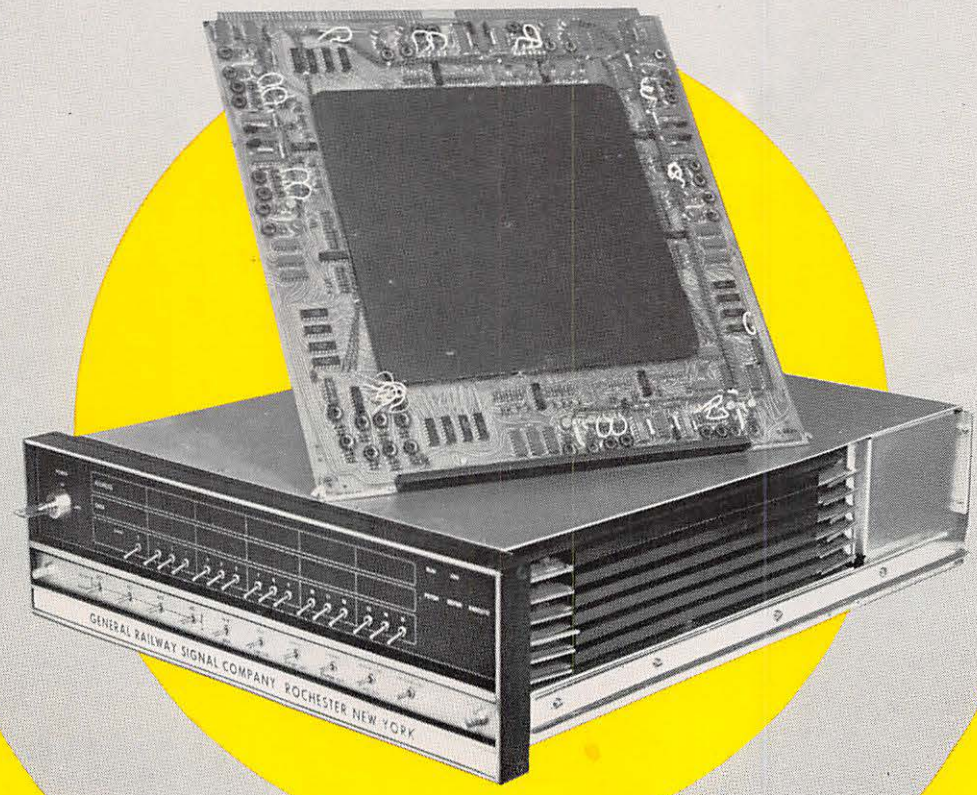
"Covering All Communications, Data Processing and Signaling"

Southern works for real-time car control

CF75 G 55
R R TAYLOR
27W 174 BAUER RD
NAPERVILLE ILL 60540

Tough little eggs... in several baskets

The GRS Distributed Computer System will fit your car classification needs precisely... and you can expand it anytime



Tough Little Eggs:
A basic minicomputer module takes only 10½ inches of height in a standard 19-inch rack. Typically with only five circuit boards (ten at most) it has a mean time to repair of one-half hour—and mean time between failures of thousands of hours.

In Several Baskets:
A specifically assigned minicomputer handles each major portion of the total control task—one for automatic switching, one for automatic retarder control, one for inventory and reporting, and so on. All, or any parts, of the car classification task can be selectively—or totally—computerized.

A single minicomputer can operate as standby for as many as three operating minicomputers, thus further reducing possible delay time.

Before you decide on a monolithic computer plus standby duplicate, let us show you how our Distributed Computer System can do a better job for you. We also furnish the interface hardware and the process control software.

GENERAL RAILWAY SIGNAL COMPANY GRS

A UNIT OF GENERAL SIGNAL

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APRIL 1974 VOL. 5 NO. 4

RSC RAILWAY SYSTEM CONTROLS

"Covering All Communications, Data Processing and Signaling"

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Published monthly by Simmons-Boardman Publishing Corporation, 508 Birch St., Bristol, Conn. 06010, with executive office at 350 Broadway, New York, N.Y. 10013. Second class postage paid at Bristol, Conn. 06010 and at additional mailing offices.

Member of the Audit Bureau of Circulations (A.B.C.) Name registered in U.S. Patent Office. Printed in U.S.A. by the Johnson Press, Inc., 800 North Court St., Pontiac, Ill. 61764.

Member of

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Subscriptions: Address all subscriptions and correspondence concerning them to: Circulation Department, Railway System Controls, P.O. Box 530, Bristol, Conn. 06010. Change of address should reach us three weeks in advance of the next issue date. Send old address with the new, enclosing if possible your address label. The Post Office will not forward copies unless you provide extra postage. Duplicate copies cannot be sent.

Subscription price to railroad employees only in U.S., Possessions, Canada and Mexico, $4.00 one year, $6.00 two years. All others $7.00 one year, $10.00 two years. Payable in advance and postage free. All other countries: $10.00 one year, $20.00 two years. Single copies 90¢.

POSTMASTER SEND FORM 3579 TO P.O. BOX 530, BRISTOL, CONN. 06010.

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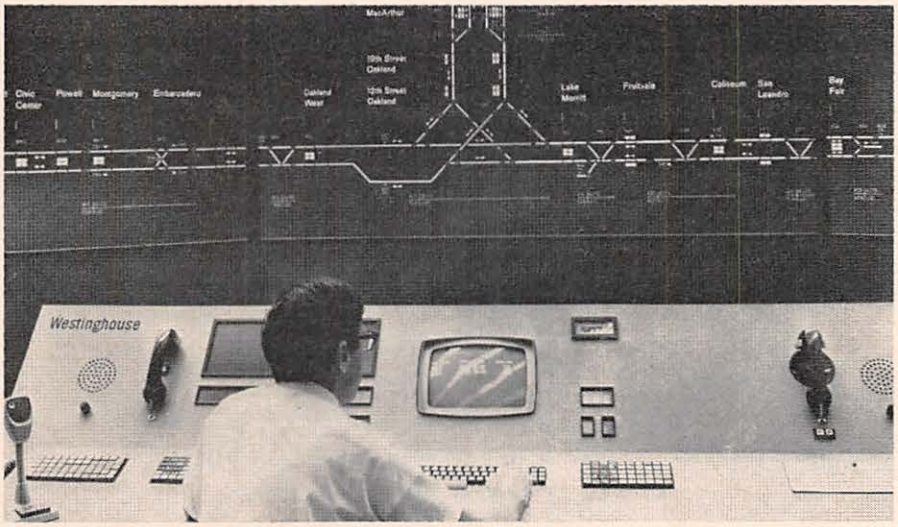
RSC News



BART system testing new control package

San Francisco's Bay Area Rapid Transit is testing a backup computer system designed to monitor and correct any failures which have haunted the BART system ever since it opened in 1972. The series of malfunctions—including false signals, unscheduled door openings, and the derailment of one train—forced BART to temporarily abandon its $35-million hands-off controls, and instead rely on flagmen. As a result, state regulators will not permit BART to run its trains through the system's vital 3.6-mile Bay tube connecting suburban lines to downtown San Francisco until the automatic control system works.

The backup system being tested was devised by two Hewlett-Packard Co. engineers who have designed the software programming package which will depend on a computer built by Computer Automation, Inc. Developers of the original control system, Westinghouse Electric Corp., got the $1.3-million order to install the prototype backup system.

David S. Cochran, and Leonard S. Cutler were assigned to the project by H-P Vice President Bernard M. Oliver, who served on the state senate's special panel appointed to investigate BART. The two came up with a software package that will be incorporated in 52 digital processors placed at 34 stations inside cabinets housing the original wayside equipment.

The H-P backup monitors the Westinghouse system, and is able to distinguish between real and false signals in a block by checking conditions in the surrounding blocks. Under the new backup system, the H-P logic will reject an occupancy signal if it is not preceded by a signal from an earlier block, and it holds the train until it is detected by the following block. If a "ghost train" signals that it occupies a block, the system will reject the signal because it did not detect the train earlier.

Computers in transportation featured at Chicago conference

A special day and one-half program on computers in transportation will be featured as part of the 1974 National Computer Conference & Exposition to be held May 6-10 in Chicago's McCormick Place. The 74 NCC, sponsored by the American Federation of Information Processing Societies, will also feature this year's largest display of computer hardware, software, systems and services by more than 250 participating organizations.

The transportation program, under the direction of Paul G. Mercer, Director, Business Planning & Control, Eastern Airlines, will consist of five major sessions beginning Monday afternoon, May 6, and running through Tuesday afternoon.

"The program," according to Mercer, "will provide a forum for the latest views from top representatives trucking, airlines, railroads and related transportation industries. Session will cover a number of data processing applications developed independently by the transportation industry in such areas as operations control, equipment inventory and location, and system communications."

Techniques developed for maximizing equipment utilization and control will receive special attention. One aspect will be a detailed analysis of centralized and localized systems controls as they apply to specific types of transport. There will also be a general overview of data processing applications in transportation plus a user overview of computerized transportation and distribution.

GTW to modernize and consolidate communications

A microwave system is under construction to modernize and consolidate Grand Trunk Western's communications. The system which now partly crosses Michigan, Indiana and Illinois, will cover all of the 400-mile GTW line by the end of 1974. Under this program all existing communications services of the railroad will be linked within the Motorola MR-200 Microwave RF equipment and MC-300A Solid State Multiplex systems.

Along with filling increasing communication needs, "In the future, we expect that microwave will sharply reduce maintenance costs borne by the railroad," says Jack D. Chase, general superintendent communications for GTW. "We're in a risky weather area where ice, sleet and high winds often disrupt our pole line services and we're located in what is regarded as a tornado area with pole line damage varying from minor each year to major . . . once very ten years."

He cited a 1969 tornado which ripped the Indiana-Michigan area, wiping out miles of telephone and telegraph lines and requiring months to replace. "We believe we're going to save the cost of going out to repair pole lines, at the average yearly rate of one-tenth of the cost of that major incident." In addition, Mr. Chase said, "Grand Trunk Western will realize a substantial savings in not having to lease circuits for its communication network." Looking at the Capitol expense for constructing microwave he is convinced the system will pay for itself under acceptable economics principles.

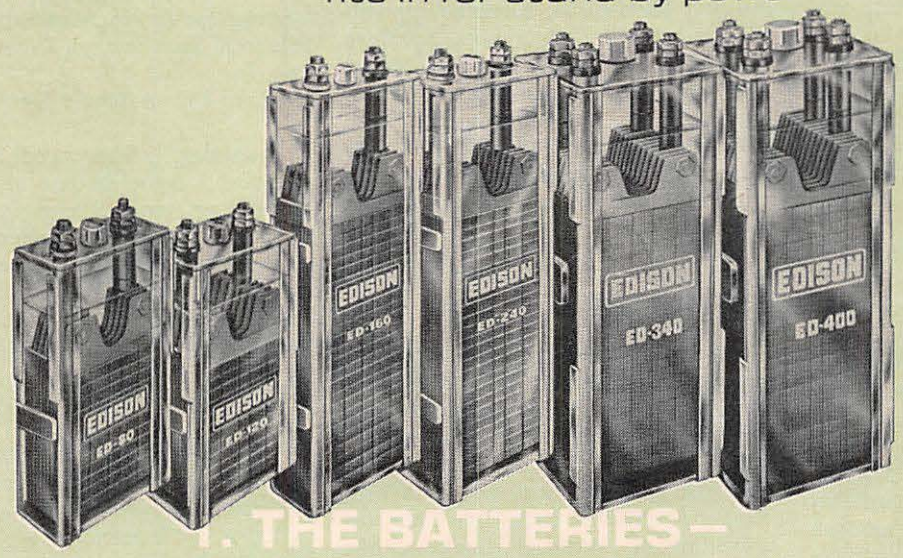
The new system now has approximately a 300-channel capability supplying direct-dial telephone trunklines, facsimile circuitry, train and police dispatching facilities, etc. According to Wes Severence, radio supervisor for GTW, microwave has greatly increased the reliability of all the circuits already transferred to the partial system.

RELIABLE HIGHWAY CROSSING PROTECTION

Here's where

EDISON

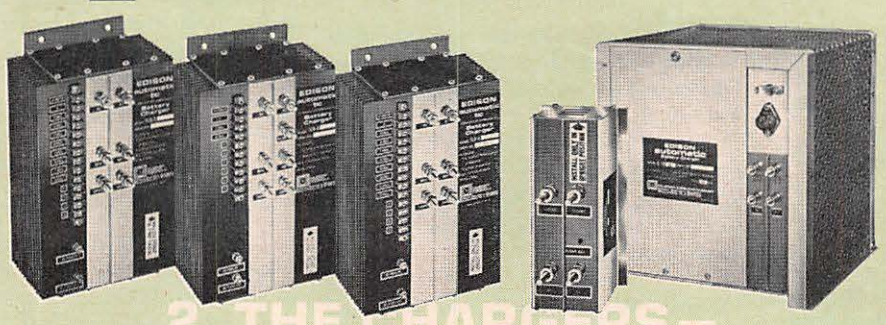
fits in for stand-by power



1. THE BATTERIES—

Long life Edison Nickel-Cadmium Storage Batteries engineered to provide consistently dependable performance

- rated on the safe, conservative side
- rugged, transparent cases and covers to permit completely visual maintenance
- six types with capacities ranging from 80 to 400 ampere-hours . . . a full line to fit the requirements of any highway crossing installation



2. THE CHARGERS—

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- all solid state and featuring completely automatic operation after original installation is made
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- temperature compensated operation on several models
- five standard models available with ratings from 1.5 to 40 amperes

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RSC People

CHESSIE SYSTEM.—Joe M. Beavers, engineer signals, Huntington, W. Va., appointed superintendent signals and communications—maintenance and construction there.

At Baltimore: **Louis P. Diamond,** transportation systems planner, named senior systems engineer. **John J. Whalen,** manager electronic development, named assistant director-technical services. **R. Paul Williams,** assistant vice president-data services, named assistant vice president-management information services.

Robert L. Hintz elected a vice president of **Chesapeake & Ohio** and **Baltimore & Ohio,** Cleveland. Mr. Hintz has been assistant to the president since May 1972 and vice president-executive department of the affiliated **Western Maryland** since Jan. 1973. In his new post, Mr. Hintz assumes responsibility for management information services, including data systems development and data processing operations. He also retains responsibility for corporate auditing and contracts of C&O and B&O as well as his existing duties with the WM.

William H. Hale has been appointed technical data analyst in advance systems planning, Baltimore. He had been secretary to vice president-planning since 1965.

DENVER & RIO GRANDE WESTERN.—R. N. Lehnertz appointed assistant superintendent of communications, Denver.

P. B. Krowell appointed computer & electronics supervisor, Signal Department, Denver.

FLORIDA EAST COAST.—B. L. Burke appointed general signal inspector, St. Augustine, Fla., succeeding **U. D. Payne,** who retired Feb. 1 after 48 years with the FEC. **R. O'larte** named circuit engineer, St. Augustine.

METROPOLITAN ATLANTA RAPID TRANSIT AUTHORITY.—Jeffrey B. Trattner, staff counsel, Electronics and Space Division, **Emerson Electric Co.,** St. Louis, Mo., appointed chief staff counsel for MARTA, effective March 5. He will establish the office of staff counsel, recruit additional staff and develop certain procedures for the Authority in the field of procurement and related matters.

SOUTHERN.—R. Jackson Witcher, communications and signals supervisor, appointed coordinator, communications and signals, Atlanta, Ga. **James W. Woods,** senior claim agent, appointed superintendent safety, Piedmont Division, Greenville, S.C. **Thomas F. Madden** and **Jefferson R. Kitchens** appointed data reporting supervisors, **Kathleen W. Scott,** shift supervisor-data input, and **Grace H. Nix,** assistant supervisor, MIS, Atlanta. Mr. Madden had been clerk, Inman Yard; Mr. Kitchens, data processing shift supervisor; Ms. Scott, assistant supervisor and Ms. Nix, data input operator.

SUPPLIERS

Norman P. Erkel has been appointed manager-management information systems, **Westinghouse Air Brake Division, WABCO,** Pittsburgh. Mr. Erkel will be responsible for the establishment of both manual and electronic data processing procedures to provide optimum utilization of divisional resources. Mr. Erkel has served in various engineering and managerial capacities since joining WABCO in 1960.

Robert E. Cappalli has been appointed marketing manager, components and materials group, **Westinghouse Electric Corp.,** Pittsburg. Mr. Cappalli was formerly marketing manager, wire division, Abingdon, Va.

Thomas A. Rourke has been appointed president of **Lynch Circuits Inc.,** Mountain View, Calif. **Lynch Communication Systems Inc.** acquired Cirtel North Inc. in August 1973 and renamed this subsidiary Lynch Circuits Inc., effective Jan. 1. The company manufactures printed circuit boards for the electronics industry.

Warren W. Herlihy has been named sales manager, **Rydax, Inc.,** San Rafael, Calif. Mr. Herlihy previously was western regional sales manager for Aerotron, Inc.

RSC Publications

Questions about making storage battery installations last longer and reducing maintenance are answered in the C & D Batteries' Installation and Operation Instruction Manual, 12-600. *C & D Batteries.*

Circle 150 on Reader Service Card

A new booklet "About RF Transmission Lines" has been written for the many people engaged in two-way radio communications. The booklet discusses the application of transmission lines and how they affect communication systems. *Decibel Products, Inc.*

Circle 151 on Reader Service Card

A new 20-page handbook, "A Guide to the Operation and Application of Solar UPS Uninterruptible Solar Power Systems for Communications" is available from *Spectrolab, a Division of Textron, Inc.*

Circle 152 on Reader Service Card

A catalog listing specifications and prices of a complete line of Ultrasonic Transducers and Accessories is now available. The catalog includes a complete line of transducers, including patented ultrasonic wheels, especially suited for rail testing and automatic inspection systems. *Balteau-Sonatest Corp.*

Circle 153 on Reader Service Card

A 16-page manual covering the installation, operation, and maintenance of pocket-plate nickel cadmium storage batteries has been published by NIFE Inc. The booklet covers various topics such as construction, electrolyte, mixing of dry-flake electrolyte, battery and battery/charger connections, float charging, gassing, watering, and special maintenance procedures. *NIFE Inc.*

Circle 154 on Reader Service Card

A 72-page catalog, "General Electric Wires and Cables", has been published covering product feature and application information on power and control cables, portable cables, flexible cords, fixture and motor leads, electronic wires, and industrial automation and communication cables. *General Electric, Wire and Cable Products Dept.*

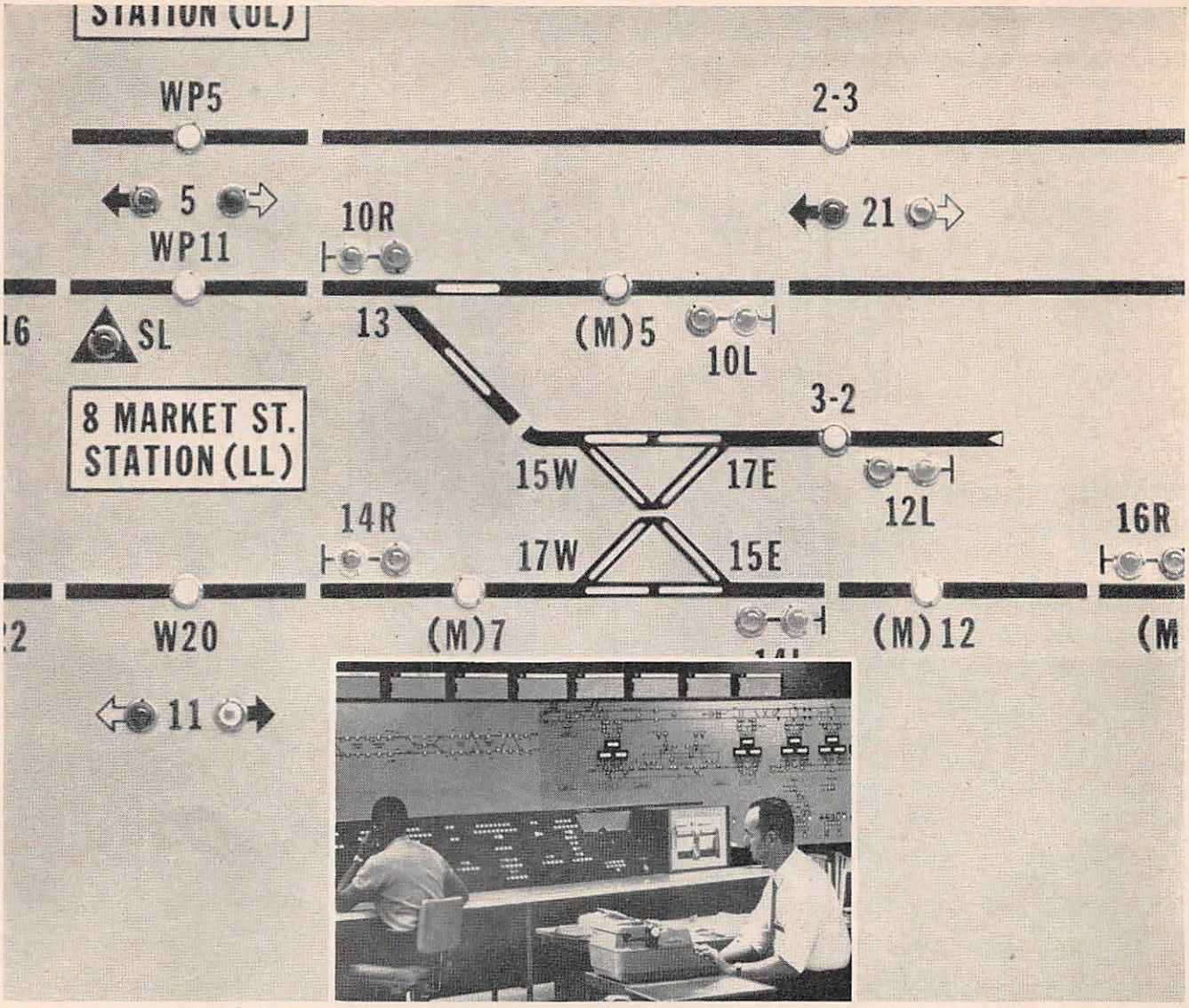
Circle 155 on Reader Service Card

Programmable measurements of electromagnetic interference in the range 10 KHz to 32 MHz are performed by the instrument described in Data Bulletin RFI-104A. The 8-page brochure contains general background material on EMI testing and EMI meters, plus applications, specifications, block diagram, accessories and ordering information. *Singer Instrumentation.*

Circle 156 on Reader Service Card

ABC's of Computers, third edition, by Allan Lytel and Lawrence Buckmaster. The book describes the two basic types of computers—analog and digital—and proceeds with simplified explanations of circuits, numbering systems, arithmetic operations, symbolic logic, logic circuits, counters, memory storage, input/output devices, programming, and maintenance. *Howard W. Sams & Co., Inc.*

Circle 157 on Reader Service Card



Here's how 14.5 miles of rapid transit stays on time. WABCO time.

PATCO's Lindenwold line races between Philadelphia and Lindenwold, N.J. carrying 38,000 passengers daily. It has an outstanding record for on-time service.

Key to the service is the WABCO Supervisory System at Camden Central Control. The track diagram panel continuously displays the location of all traffic on the line along with status of switches and signals. The WABCO control console provides control or monitoring for the following functions.

- automatic or manual control of switches and signals
- automatic or manual control of turn around patterns
- traffic normal or reverse control
- advance or retard control of automatic train dispatcher
- switch point snow melter control
- subsystem-in-use indication for digital data system sharing
- lamp test control for console and track diagram
- alarm acknowledge-pushbutton and indication
- control-reset command for request cancellation

Supervisory control of substations is provided on a separate panel.

Combine this control with voice communications throughout the system over a TRAINPHONE® System and you have some idea of why the Lindenwold line runs so well. We'd like to tell you more about it.

Write: Westinghouse Air Brake Company, Transportation Systems Group, Union Switch & Signal Division, Pittsburgh, Pa. 15218.

TRANSPORTATION FROM THE WORD GO

The WABCO Transportation Systems Group is: Union Switch Signal Division, Westinghouse Air Brake Division, WABCO Ltd., Cardwell Westinghouse Company, Freios e Sinais do Brasil, S.A. In Transportation, WABCO is also 17 European operations and licensees and agents throughout the world.

WABCO

An American-Standard Company

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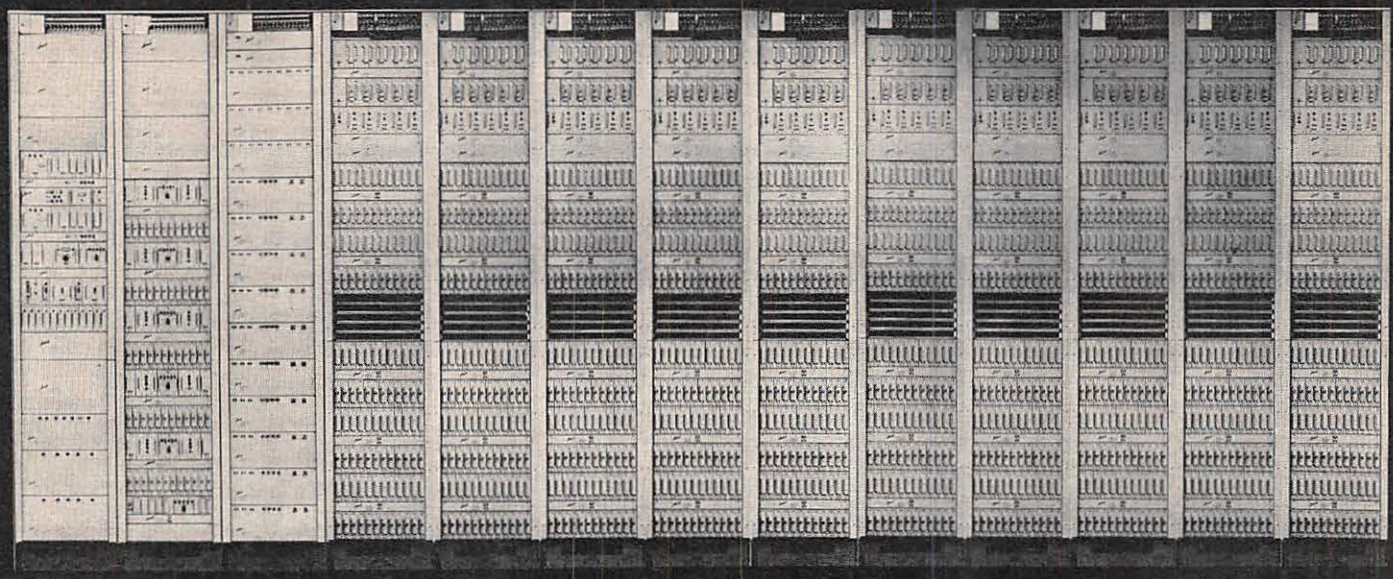
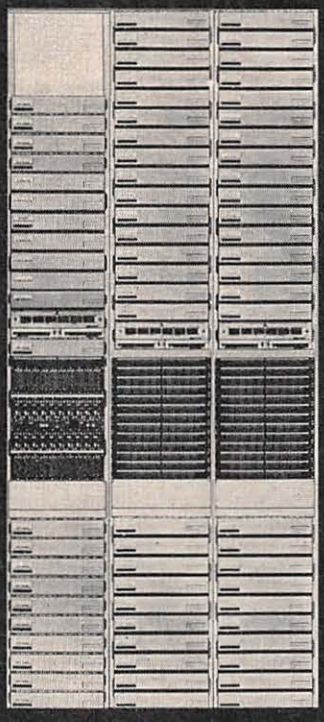


Before.

Thirteen 9-foot, 19-inch racks—600 channels.



After.

Three 11½-foot, 19-inch racks—600 channels.

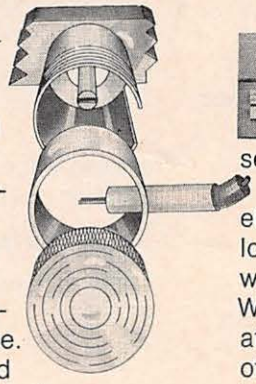
Now our 46A3 multiplex lets you put more of your money into communications, less into concrete.

Since our new 46A3 has shrunk 600 multiplex channels to fit into three 11½-foot racks (or four 9-foot racks—your option) you might naturally assume that floor loading has gone way up. It hasn't.

So now you can use your costly floor space more efficiently and put your money where it counts; in equipment, not concrete.

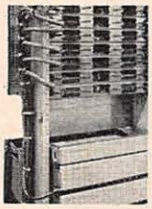
No new power plants either. Our 46A3's power requirements are way down.

Our little patented polylithic crystal filter deserves triple credit: once for that dramatic overall size reduction, once for cost reduction and once again for the high reliability, quality performance and versatility of our 46A3.



Speaking of patented items, there's a patent pending on our coaxial connector. It simplifies installation so much we use it for both intra- and inter-bay wiring.

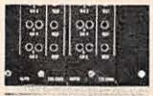
But, coaxial connectors aren't the only simplification of 46A3 wiring. Our

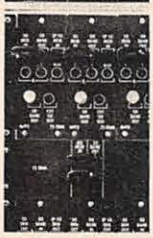


factory-wired racks cut installation costs to the bone. They go a long way toward reducing your maintenance time too.

Since our VF jackfields use miniature tip-ring-sleeve jacks, more space is saved. The HF jackfields also save space by using miniature coax jacks. And since the HF jackfields are modular, you can equip your system with as many or as few as you need.

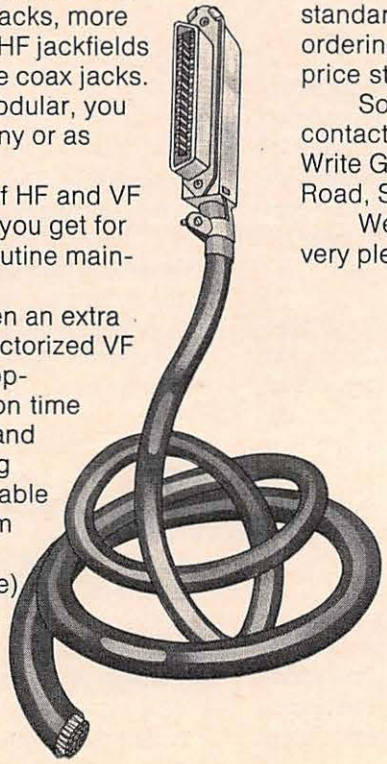
Of course, a big advantage of HF and VF jackfields is the complete access you get for



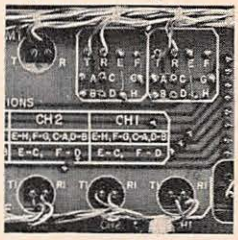


fast in-service and routine maintenance testing.

We've even taken an extra step: Optional connectorized VF jackfields reduce drop-connection installation time by as much as 50% and minimize cable wiring errors. Tell us what cable length you need (from our connectorized multiplex to your distribution frame) and that's that.

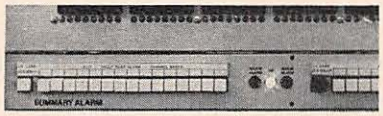


Of all these innovations, the one that you might find most exciting is the 46A3's factory-wired standard assemblies based on a modular, plug-in concept. Combine these standard assemblies with strapping options and you have a highly flexible system designed to accommodate a variety of users and multiplex applications.



Channel strapping options are clearly and completely identified on the back of the shelves for fast, error-free installation.

With a comprehensive alarm system and full-time monitoring; normal operations, routine maintenance, troubleshooting and service restoral are as fast as they are easy.



But, all the 46A3's improvements haven't been electronic. We've used plastic and aluminum for a lower-cost, lighter-weight package. We've even included attractive snap-on plastic covers for the front and back of the shelves. They give you added safety as well as better appearance.

Another non-electronic improvement: Our standard assemblies have simplified engineering and ordering, making it possible to offer you a volume price structure.

So, before you make any multiplex decision, contact us for more information about our 46A3. Write GTE Lenkurt, Department C134, 1105 County Road, San Carlos, CA 94070.

We have a rackful (or, rather three racks full) of very pleasant surprises for you.

GTE LENKURT

Circle 6 on Reader Service Card.

1. Title: DIRECT CURRENT NEUTRAL RELAY-CONTACTS

2. Defintion:

Contact: A conduction part which co-acts with another conducting part to open or close an electrical circuit.

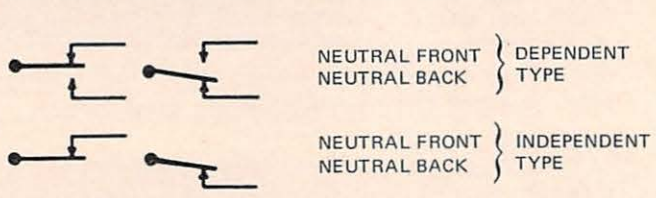
Back: Contact, A part of a relay against which, when the relay is de-energized, the current carrying portion of the movable neutral member rests so as to form a continuous path for current.

Front: Contact, A part of a relay against which, when the relay is energized, the current carrying portion of the movable neutral member is held so as to form a continuous path for current.

Dependent: Contact, A contacting member designed to complete on any one of two or three circuits depending on whether two or three way device is considered.

Independent: Contact, A contacting member designed to complete one circuit only.

3. Symbol:



4. Description:

Fig. 1 is a cut-away of one manufacturer's typical dc relay. The principal parts are identified in the illustration and will be frequently referred to in further studies of relays. Relays of other manufacturers will contain similar parts which may be arranged differently. Compare location of binding posts and contacts with those illustrated in Fig. 2.

Attached to the armature, but thoroughly insulated therefrom, are metallic movable or heel contacts. The contacting surface of the movable contacts are metal, silver impregnated carbon or similar composition, depending on the type of relay and service in which it is to be used.

Fig. 2 illustrates another model of a neutral relay shown in an energized position.

When the coils are energized the armature is attracted upward and carries the heel or movable contact with it. The heel contacting surface makes with the front contact. When energy is removed from the coil the armature drops away by gravity because the magnetic force

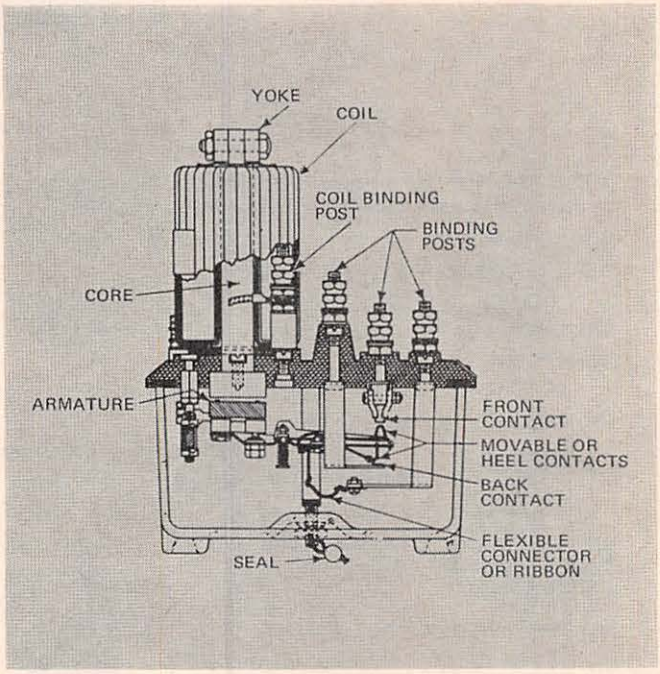


Fig. 1.

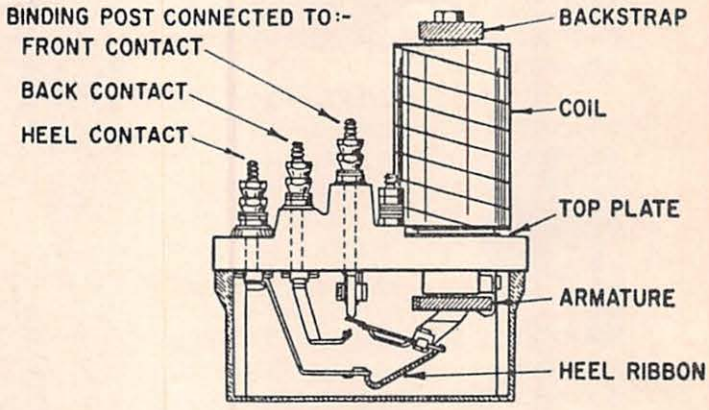


Fig. 2.

is removed. The heel contact surface leaves the front contact surface and comes to rest on the back contact.

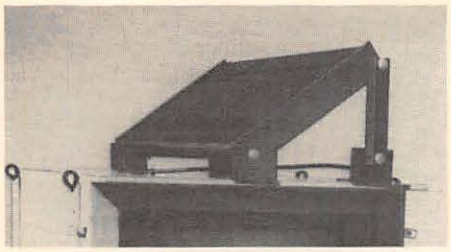
To utilize the contacts, electrical circuits are wired to the external binding posts. Note that the heel contact is joined to its binding post by a heel ribbon or flexible connector. This allows the contact to move freely with the armature without impeding the armature's motion.

Shelf or wall mounted relays are most commonly supplied with either two, four, or six contacts; i.e. two fronts two backs, two heels, etc.

Direct current relays equipped with heavy duty contacts are available for use in high current or high voltage circuits.

5. Purpose and Application:

AAR symbols are used in this bulletin to represent the relay components shown in circuit plans. (continued)



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The circuits in Fig. 3 are designed so that relay Y will not pick up unless relay X is energized. There is a circuit in which the lamp will not illuminate unless both relays are de-energized. These circuits were selected to demonstrate the use of contacts.

For simplicity a manual switch to control relay X has been used. The dotted line represents the switch in the open position.

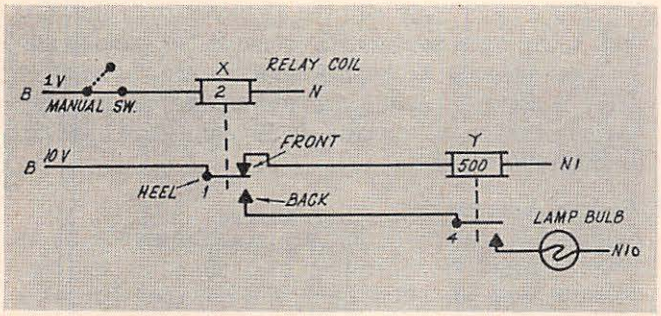


Fig. 3.

In Fig. 3, B1 and N1 denote positive and negative connections respectively to a 1-volt dc power source. Similarly B10 and N10 are connections to a 10-volt dc power source. When the switch is closed there is a complete electrical circuit between B1 and N1. Current will flow from B1 through the switch, through the coil of relay X to the N (negative) terminal. The current in the coil magnetizes the core which in turn picks the armature up. The heel contact is moved up by the armature to make with the front contact surface. This establishes a path for current flow from the 10-volt source to energize relay Y, specifically from B10 to the heel of relay X, through the heel. This energizes relay Y; with both relays up, the light is out. The lamp cannot be lit unless both relays are de-energized since the current path for the lamp is closed through the heels and backs of both relays. Use of one of the relay contacts would have been sufficient to control the lamp. Two were used here to illustrate that often contacts of several relays will be inserted in the control of a device to check the conditions of several circuits.

When the switch is opened relay X is de-energized, the armature drops by gravity, the heel from the front to the back contact. With the front and heel of relay X open energy is removed from the coil of relay Y dropping its heel to the back. There is now a path for current from B10 to N10 through the heel and backs of both relays and through the lamp.

Further study will indicate that relay circuitry is versatile and advantages which will become apparent include:

A. One circuit can control many secondary circuits, e.g. by controlling the energy through the coil of one relay many secondary circuits are possible through use of its contacts.

B. A low voltage circuit may control a higher voltage circuit i.e. in the example circuit used in this bulletin, a relay that was operated from a 1-volt source controlled a 10-volt circuit through its contacts. In some cases the voltage and current in the secondary circuits are quite high, requiring relays with special contacts.

C. Functions may be controlled remotely, e.g. in traffic control systems a code may be produced at a central location by the opening and closing of relay contacts in a predetermined sequence. The code is transmitted over line wires to distant locations where other relays respond to the information and control switch or signal operations in the field.

D. Functions may be controlled in a definite sequence, e.g. at a crossing protection location a relay connected to the rails of the track is de-energized when a train occupies the specific track section. When the track relay (TR) drops, its contacts open the control circuit of another relay at the crossing. When this crossing relay (XR) is de-energized, its back and heels close to energize a relay which controls the flashing light circuits. Then the flasher relay (FR) is energized, its contacts open and close at a predetermined rate. The lamp circuits are connected through these contacts and their oscillation causes the lamps to turn on and off.

E. Storage of information may be stored by means of a stick circuit. A stick circuit can be defined as a circuit used to maintain a relay energized through its own front contact.

Briefly, a stick circuit is so designed that the stick relay receives its pick-up current through contacts of other relays. These contacts must all be in the proper position to pick the relay up. Once picked up, a second current path to the stick relay coil is established through a heel and front of the stick relay. This secondary or holding circuit will keep the stick relay energized even though the energy supplying the pick-up circuit is interrupted.

By remaining up after the pick-up circuit is opened the stick relay is storing the information that the proper pick-up circuit did exist previously.

6. General Information:

Contact replacement or adjustment is normally a shop operation; therefore contacts do not require any field maintenance but as mentioned in the initial bulletin on Direct Current Neutral Relay, field forces are responsible for periodic visual inspection of the relay interiors. Corrective action must be taken if contacts are found to be badly burnt, pitted or cracked.

7. Detailed Operation:

Information regarding contact current and voltage capacities along with contact materials, adjustment, etc. is available in the manufacturer's service specification bulletins.

1. Title: DC RELAY OPERATING CHARACTERISTICS

2. Definition:

(a) Operating Characteristics: As applied to a relay, the measure of the electrical values at which a relay operates (Drop-away, pick-up, working value, etc.)

(b) Drop-away (or release value): The electrical value at which the movable member of an electromagnetic device will move to its de-energized position.

(c) Pick-up: The electrical value which, when applied to an electromagnetic instrument, will cause the moving member to move to the position which will just close the front contacts or visually indicate its energized position.

(d) Working Value: The electrical value which, when applied to an electromagnetic instrument, will cause the moving member to move to its full energized position to provide maximum front contact pressure.

3. Symbol: None

4. Description:

As defined above, the operating characteristics are the electrical values at which electrical apparatus operates. A label affixed to the inside of the transparent contact compartment contains the specific operating characteristics of a relay. Also shown is the relay serial number, coil resistance, initials of person who inspected relay and the date of inspection. A typical track relay label is illustrated in Fig. 1.

DROP AWAY		PICK UP		WORKING		SER. L-270579
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	OHMS 2
.108	.054	.206	.103	.206	.103	INSP. DATE G.a.R. 9/6/71
SLOW REL. ..... SEC. AT ..... V.		SLOW P. U. ..... SEC. AT ..... V.		ORDINARY ACT.		

Fig. 1

5. Purpose and Application:

Operating characteristics must be provided for each piece of electrical apparatus in order that design staff may properly select the power requirements and capacity of the circuit. Field personnel must also be aware of the importance of consulting the characteristics label to ensure that through circuit adjustments they do not exceed the electrical tolerance of the equipment or circuit.

As an example of application of the use of the operating characteristics, consider the conventional track circuit where the coil of the track relay receives its energy from a track battery. For track circuit adjustment, adjustable resistors are connected in series with the relay coil and battery. In one method of track circuit adjustment the signal employee is required to adjust the normal current flow through the relay coils to a value 50 percent above the relay working value. To do this, insert an ammeter in the coil circuit and adjust the resistor until the current reading is 50 percent greater than the value shown on the relay characteristic label.

If the circuit referred to in the preceding paragraph utilized a track relay with the characteristics shown in Fig. 1, the signalman would note that the working current is 0.103 amp. He would calculate that 50 percent of 0.103 is approximately 0.052 amp and adjust the relay series resistor to provide 0.155 amp (0.103 + 0.052) through the relay coil.

6. General Information:

Although signal construction and maintenance forces must consult the operating characteristics for relay identification and adjustments it is not normally part of their duties to test that relay operation does conform with the characteristics shown. Many railroads have field inspection forces who make periodic tests to determine if relay operating characteristics are within acceptable tolerances.

When relays are found defective they are replaced in kind and shopped. It is generally considered poor practice to repair relays in the field because of the possibility of foreign material entering the relay. Relay shops are equipped with precision instruments for accurate calibration in a relatively dust free environment.

All employees should be familiar with their company's policy for inspection, repair and replacement of relays.

7. Detailed Operation:

When designing relays, the manufacturers attempt to keep the power requirements as low as practical, bearing in mind that dependable and safe operation must result.

The range in operating characteristics between relays is significant and necessary.

Two governing factors considered in establishing a relay's operating values are:

(a) The voltage of the circuit in which the relay will be used.

(b) The type of relay; i.e. neutral, slow release, biased, etc.

NOTE: DC relays used in signaling are classified as track or line relays. Any relay which receives all or part of its operating current through the rails of the track is a track relay. A line relay does not receive any of its operating current through the rails of the track.

Three of the most commonly used relays have been selected for the discussion that follows. They are a neutral track relay, a neutral line relay and a slow release line relay. Typical characteristic labels for each are illustrated in Fig. 2.

DROP AWAY		PICK UP		WORKING		SER. L 270579
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	OHMS 2
.108	.054	.206	.103	.206	.103	INSP. DATE H.a.R. 9/6/71
~~SLOW REL.~~ ..... SEC. AT ..... V.		~~SLOW P. U.~~ ..... SEC. AT ..... V.				ORDINARY ACT.

(a)

DROP AWAY		PICK UP		WORKING		SER. L 262396
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	OHMS 500
1.85	.0037	3.50	.0070	3.50	.0070	INSP. DATE A.B 6/1/72
~~SLOW REL.~~ ..... SEC. AT ..... V.		~~SLOW P. U.~~ ..... SEC. AT ..... V.				ORDINARY ACT.

(b)

DROP AWAY		PICK UP		WORKING		SER. L 73226
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	OHMS 250
2.70	.0108	5.95	.0238	6.55	.0262	INSP. DATE B.P. 4/6/72
SLOW REL. 1.8 SEC. AT 8.0 V.		~~SLOW P. U.~~ ..... SEC. AT ..... V.				~~ORDINARY ACT.~~

(c)

Fig. 2.

Note that the labels contain voltage and current levels for drop-away, pick-up and working values. Note also that the pick-up and working values are generally shown to be the same. By definition the pick-up value would be less than the working value; however, they are considered to be the same. This is because signal circuits are designed so that when the proper voltage is applied to the relay, sufficient current flows through the coils to provide maximum contact pressure in the energized position. As a matter of fact, pick-up has become the more commonly used term to describe the fully energized values.

The labels also include the coil resistance in ohms. Track relay coil resistance will normally range from less than one ohm to four ohms and line relays are generally one hundred ohms or more.

Provision is made at the bottom of the label to indicate any special operating features of the relay. The label in Fig. 2(c) is from a slow release relay. This relay will remain up for 1.8 seconds after an energizing voltage of 8 volts is removed from the coil circuit.

To describe the differences in characteristics between types of relays, those in Fig. 2 will be compared. Those not familiar with typical track and line circuit operation should refer to Fig. 3 and the explanation found later in this bulletin before proceeding.

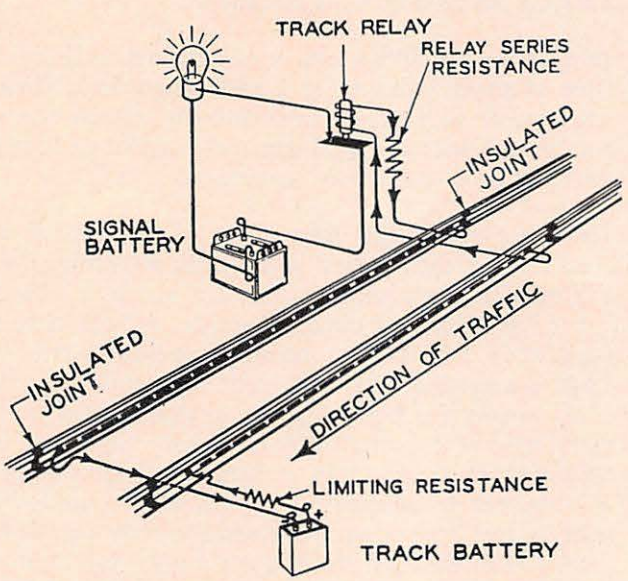
There are significant differences in the amount of operating current required in the track relay, Fig. 2(a), and the line relays shown in Fig. 2(b) and 2(c). This is due to the variance in circuit operation. In track circuit application the relay is normally energized until a shunt is applied across the circuit. This shunt is usually the wheels and axles of cars or engines. The amount of resistance to current flow offered by the shunt is dependent on many factors including rusty rails, weight of train, etc. In any case the shunt never provides a path of zero resistance and since the relay coil is in parallel with the train shunt, some current will continue to flow through the coil. However, this flow of current will be less than the required drop-away value.

For this reason the pick-up and drop-away current for track relays are much higher than for line relays. The voltage to line relays is either on or off. When a line circuit is opened there are no alternate current paths to the line relay coil. Because of this, line relays are designed to operate on very low currents, to conserve power.

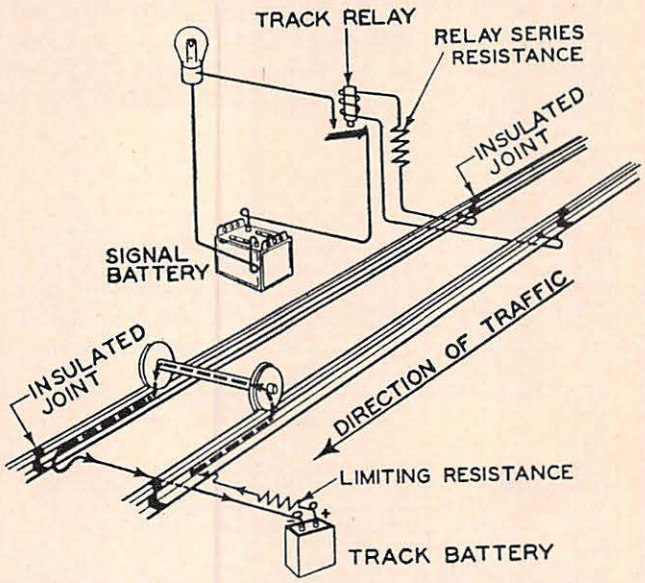
If the track relay were operated at line relay values, the current flowing through the coils when the track is occupied by a train would continue to keep the armature up, which could not be tolerated. Through proper selection of components and circuit adjustment the current through the coils with the track shunted would be far less than 0.054 amperes which is the drop-away value of the track relay in Fig. 2(a).

Another factor that must be considered in track relay design is the fact that even when the track circuit is unoccupied the current through the coils will fluctuate. This is caused by variations in ballast resistance. When ballast is wet its resistance is lower than when dry or frozen, therefore on wet days some current will be shunted from the coil. If the tolerance between pick-up and drop-away were as narrow as the line relay in Fig. 2(b), (pick-up 0.0070 amp, drop-away 0.0037 amp) which is less than 5 milliamps, the circuit would not be reliable.

The slow release line relay in Fig. 2(c) operates at slightly higher values than the neutral line relay in Fig. 2(b). To provide the slow drop away feature, it is necessary to maintain the magnetic flux for a period after the voltage has been removed from the coil circuit. One method often employed is to replace part of the coil windings with copper slugs. The slugs being



(a) Unoccupied track circuit



(b) Occupied track circuit

Fig. 3

good electrical conductors will provide a low resistance path for the current generated by the decaying flux of the deenergized relay and hold the relay up for a period. The higher the current that flows in the coil in the energized mode the stronger the field of flux produced. When coil voltage is removed the flux will take longer to dissipate and the relay will take longer to release.

Note that the coil resistance of the slow release relay is half that of the neutral line relay. The voltage applied to both relays would be the same but twice as much current will flow through the lower resistant coils of the slow release relay to produce the stronger field of flux.

From the pictorial illustration of track circuit operation in Figs 3(a) and 3(b) it may be seen that when the track circuit is unoccupied (normal), there is a current path from battery through the limiting resistor, through one rail of the track, the relay series resistor, the coil of the relay and back to battery through the other rail.

When a train occupies the circuit the low resistance of the train wheels and axle provide an alternate path for the current. Some current will still flow in the relay coil because the wheels and coil are in parallel. Because the wheels provide such a low resistance path compared to the relay series resistor and coil resistance most of the current will take this path. The current through the relay coil will be reduced well below the drop-away value of the relay and it will drop.

In a typical line circuit as illustrated in Fig. 4 it may be seen that several contacts are in series with the line relay coil. This relay will be energized whenever all the contacts are in the position shown. Should any one of these contacts open, the relay coil will be de-energized.

For the purpose of understanding the Detailed Operation portion of this bulletin it is important to recognize that the track relay has a small amount of current flow through its coils even when the track is shunted (occupied). The line relay has either maximum current flow or no current flow depending on whether the circuit is open or closed.

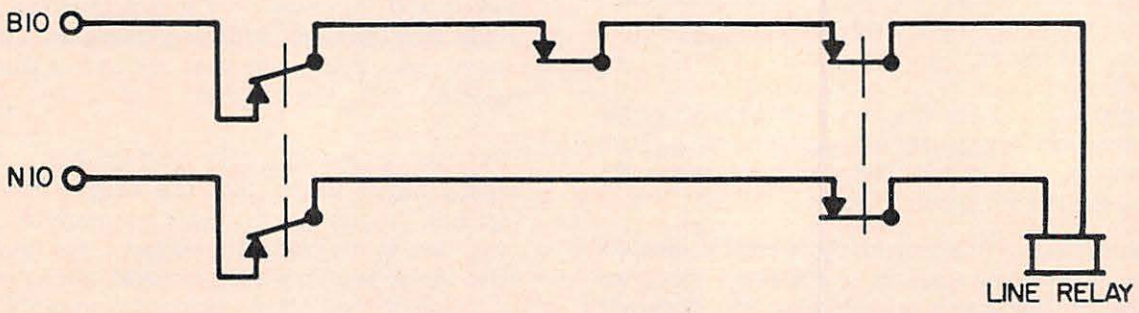
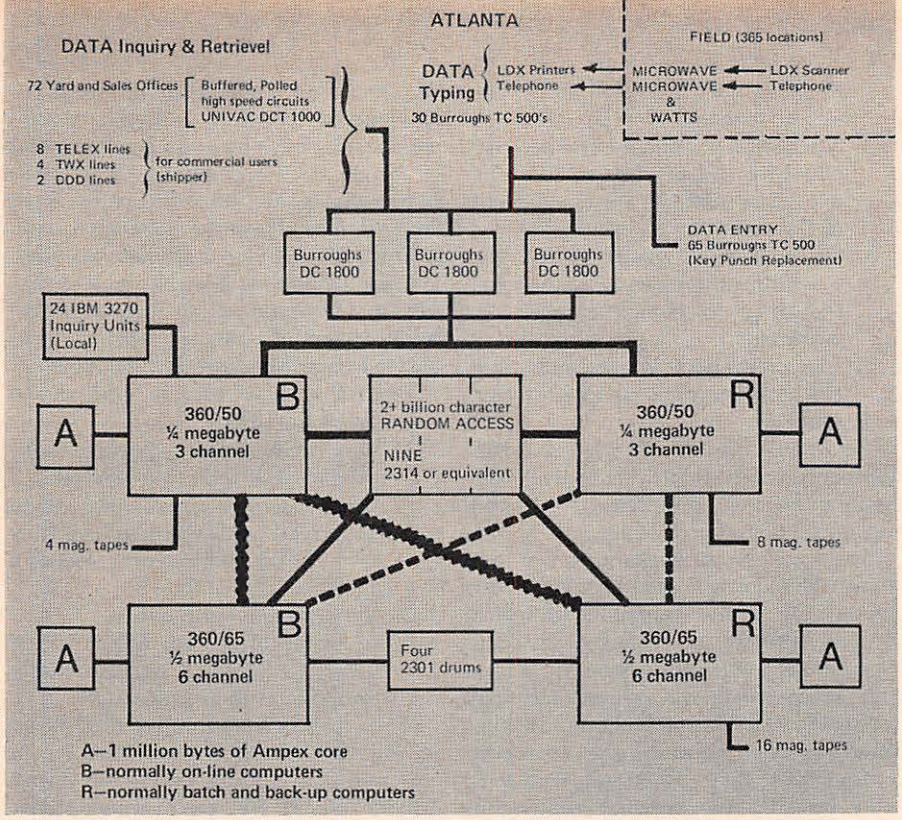


Fig. 4



Southern's approach is to design a system that will address the basic problems to be solved with greatest efficiency and avoiding unnecessary functions.

Southern's approach to freight car control

Southern Railway has had an operational on-line computer system for control of freight car and train movements since mid-1965. While the system has been refined over the more than eight years it has been operational, it still embodies the original basic design concepts which are quite distinctly different from the concept of an initial total system design.

These design concepts place great emphasis on utilizing the most straightforward and modular approach possible, specifically aimed at providing only the basic essential information and, avoiding in the original implementation, any enhancement of questionable usefulness. Large scale integration of design is avoided to not only ease implementation but to facilitate later maintenance and more importantly permit the inevitable changes required by experience of use and advancing technology to be accomplished at much lower cost.

Following is a paper presented by John L. Jones, Vice President, Management Information Systems, Southern, which discusses these concepts for the 1974 International Symposium on Railroad Cybernetics in Washington, D.C.

Southern Railway is a very profitable, highly innovative railway with a long history of leadership in many areas of our industry. Being a privately-owned company, as all U.S roads are, it has a strong profit motive which leads to certain basic company philosophies. Some of these are described as follows:

1. Our business is to make money, not save money. Therefore we are willing to invest in innovations that are progressive and profit-oriented even though there may not be cost savings immediately available.
2. Our business is very labor intensive. We are dedicated to doing our job with the smallest personnel possible—of course within safety and service standards and contractual obligations.
3. The computer and systems activities are both very important and very expensive. Therefore, top management should know how this tool is being used and how to use it, and must spend the time necessary to participate in this.
4. While it is important to have objectives, goals and a strategy for reaching them, it is very important to make progress. Therefore, we normally do not engage in a "total systems study" to define all system details in advance since generally the precise and detailed needs of the user are composed more of opinions than demonstrated use. Such details are highly subject to change by time of implementation resulting in many planned outputs being of marginal or no real value.
5. In concert with Item 4, we tend to design systems that will address the basic problems to be solved, largely ignoring any "extras" that do not clearly and directly impact the problem area. This has the effect of minimizing the cost of the basic solution.

In June of 1965, Southern Railway went on-line with a computerized system designed to track and control the movement of freight cars. This system has run continuously since that time, of course having been refined (sometimes for better, sometimes for worse) over the years. The system has gone through major redesign in certain portions, these redesigns always being based on two or more years of operational experience to assure understanding of the requirements as they actually existed, and not merely some opinions of the designers.

The system was initially developed and implemented on "second-generation" hardware of the IBM 7000 series. A major conversion occurred in change to 360 equipment in 1969. This conversion was accomplished with no system or program change by virtue of having used COBOL in the initial programming. There were no major difficulties encountered in this conversion.

The system now operates on a 360/65, a 360/50, with seven 2314 disk files. All inbound and outbound movements of all on-line freight cars at each of about 350 reporting locations are reported to the computer and include road and local trains, industry, interchange, repair track, cleaning track, rail highway and other movements.

The system retains the last 16 moves of each car on-line and in addition complete waybill data, the proper assignment and return routing for all assigned equipment, proper reverse route for all general purpose equipment, yard inventories, etc. It furnishes enhanced advance consists on important through trains, tonnage report, yard perfor-

mance reports, tracing of fleets on special cars, etc., on an on-line basis. This data is disseminated to the field over a polled high-speed communication network to 72 buffered terminals in yard and sales offices. There are also many directly connected terminals and interface to commercial teletype networks.

Finally, all data is passed to daily processes which furnish information to car distributors on existing and predicted car supply, violation of distribution or routing rules and various other monitoring information. All car mileaging and accounting is done from this data.

Locomotive and rail highway equipment is handled by the system in essentially the same manner as freight cars.

Let us turn now to the basic approaches that were taken by Southern in the design and implementation of this system as this is what really distinguishes the system from those of other railways. We will explore the advantages of these approaches as viewed by Southern management.

The first item to be discussed must be the data capture technique. It is perfectly obvious that to be useful, the data must be accurate and timely. It is equally clear that the computer itself plays no real role in this because if the data is "too late" when it is entered into the computer, it will be a little more "too late" when it comes out processed. If it is inaccurate, the computer will not correct it, one hopes the inaccuracy will be detected and the data ignored.

Therefore we believe the philosophy here should be that the reporting location should do "the fewest number of the simplest things" to minimize the number of opportunities to make an error and further reduce the likelihood of an error when the opportunity was present. It seemed clear to us that a remotely operated keyboard and/or handling of punched cards fell outside of this criteria of "fewest and simplest" and additionally required yard clerical skills and manpower.

Having in place a large microwave facility, it turned out to be both possible and practical to use high speed facsimile (a Xerox product known as Long Distance Xerography or LDX for short) which operates at 20 pages per minute. Since every car on Southern has a waybill, including empty cars, the concept is that to report a movement the man in the yard does one thing per car, that being to put the waybill into the LDX device. Thereupon we instantly have a copy of the actual operating document in our central facility at Atlanta. Clearly, a 100 car movement takes only about 5 minutes to report. The advantages of this are:

1. Requires very little clerical effort in the yard.
2. Requires very little skill and virtually no training.
3. No system is imposed on the yard office by the process so that the man does nothing for the benefit of the computer.
4. On outbound moves, since the waybills must move with the cars, reporting is complete prior to movement.
5. The equipment is extremely reliable and requires no special environment.

We know of no disadvantages to this approach other than, of course, the communications requirement which was no problem for Southern.

At low volume stations, which are about 85% of the stations but only about 25% of the volume, and which always represent an economic justification problem when an expensive device must be installed, we utilize a terminal commonly called a telephone. In this situation, when a yard wishes to report a movement, they call Atlanta and verbally transmit the data by reading it aloud to the key input operator at the other end. This has two disadvantages:

1. It is not as fast as LDX.
2. It is not as accurate as LDX.

However, these disadvantages are not highly significant since most waybills pass an LDX point and therefore only abbreviated data is needed from the telephone point and on repetitive movements (which is a high percent) only a self-checking code number need be given to the computer. The computer fills in all the information from internal files when the repetitive code is used. Also, it is in fact quite accurate because in reading the data and speaking it (as opposed to copying) the brain apparently catches most discrepancies between the eye and ear inputs.

The advantages are, in addition to those listed for LDX:

1. Very inexpensive—allowing easy expansion of reporting network.
2. Employees are already trained to dial, read and speak when they are hired—minimizing training again.
3. Very reliable hardware.
4. In event of a rare LDX failure there is a fall-back method readily available at those stations.

This, then, allows total centralization of the data input keying function in one room in Atlanta where we input 120,000 to 140,000 car movements per day on 30 input terminals (Burroughs TC-500s). The personnel for this function can then be very selectively recruited, trained and monitored as to quality and quantity of production. It also eases the problem of covering the keying operation 24 hours, seven days, with qualified personnel and greatly

Cybernetics: View from the top

Alfred E. Perlman, president of the Western Pacific, was a key figure at the First International Symposium on Railway Cybernetics held in Paris in 1963, and at subsequent sessions in Montreal and Tokyo. Invited to comment on the progress made in railway cybernetics since the first symposium was held, Mr. Perlman had this to say:

"Great strides have been made since the first conference was held in Paris in 1963. We were then working with first and second generation computer hardware and going from the batch system to real time programming.

"There are over 250 large computers at work on the U.S. railroads and we are expanding rapidly in the areas of remote terminals and mini computers.

"The greatest goal for the future is a much expanded use of data exchange by the railroads, eliminating the tremendous redundancy of data input. This will be made possible by greater accuracy of computer data input and more compatible software. The greater use of data exchange will involve an extension of common codes by the railroads and common between railroads and common within railroads. This deals with system point location code —that is, pinpointing of geographic locations. It gives us the standard shipper consignee designation. It also involves, in addition to common code, the adoption of a standard format of procedures between railroads.

"Train (Telerail Automatic Information Network) No. 1 cut the time when the A.A.R. inventory of freight cars in the United States was current from about two months to two-to-four days. And TRAIN II hopes to establish location information by car and region on each railroad. This will let us know which region it is on (mid-west, far-west, etc.). And we would know which region on each large railroad. This would permit more efficient distribution of equipment than we have today.

"Railroads are improving their communications and there is a distinct possibility of sharing microwave between railroads and its application may be available for TRAIN II.

"This is the capability of our new technology in the era of communications and control hardware. Where we go now is only limited by the complexity and cost of the software as we seek

eases the problem of changing to new input devices.

This also allows error correction to be centralized in a staff specially trained and equipped to analyze and correct errors on a very timely basis as opposed to each operator correcting his own mistakes. This specialization allows the input typist to concentrate on production but, of course, implies strong supervisory responsibility through monitoring of daily production records to assure that both quantity and quality remain high.

Another basic concept was that the system would be built entirely in a straightforward and modular way utilizing standard, off-the-shelf, tried and tested hardware and software. We very much try to minimize the number of variables we must handle in any given set of circumstances and in particular, try to maximize the benefit of having others check out early deliveries of hardware and software by vendors. This attitude may be summed up by saying "the first Christians meet the hungriest lions".

In the actual computer system design, we have always used two centralized computers for the system, one dedicated to teleprocessing, the other dedicated to the editing, filing and information systems function. The benefits of this are as follows:

1. The programs are more clearly compartmentalized for purposes of design, implementation and maintenance.
2. The teleprocessing function, which finally becomes quite stable, is generally impervious to application program errors in the other computer. Since it is the application programs that routinely are changed, they are the ones that routinely "blow-up".
3. Workload is more evenly distributed with peak-times on one machine not affecting the other.

It must be emphasized that the system is made up of straightforward modules as opposed to highly integrated large programs. This is for several reasons:

1. Original design, programming and debugging are easier.
2. Changes are easier to design, test and implement (and the only thing one can be certain of is change).
3. Usually the basic system has enough problems without adding all of the sophisticated extensions at the outset.
4. We believe it is important and beneficial to get a basic system operational and solve those basic problems based on experience before building extensions on what may be false premises.

As an example of 4 above, we did not design and implement at the outset all the reports and inquiries that we could think of that might turn out to be useful. This not only saved a huge amount of programming but, more importantly, resulted in avoidance of cost and effort to capture large amounts of data which turn out to be of doubtful utility and benefit. New data and outputs are added to the system only when operating personnel, through experience, can quite precisely identify their need and the benefits to be obtained. Our experience is that this approach is much more effective and very much less costly than the "total system approach" which tries to provide "everything for everybody" at the design level. It is equally important to recognize that nothing should be done "on-line" that can be just as effectively (from the point of view of its use) done on a periodic or batch basis. This last precept somewhat ignores the *aesthetic* senses of the programmer and many users!

Finally, whenever possible, standard software (as provided by the vendor) and techniques are used without modification. This benefits us by

1. requiring no resources on developing programs other than application programs.
2. minimizes documentation requirements.
3. permits upgrading as new versions of operating systems, service routines and computers become available.
4. minimizes training requirements and problems for new personnel.
5. allows most qualified personnel to concentrate on difficult application problems rather than programming systems problems.
6. writing all programs in a high level language (COBOL) and observing strict programming conventions greatly eases later maintenance and conversion.

We do occasionally modify some aspect of the software—for example, we were dissatisfied by the time required to "IPL" the 360. Therefore, we modified the process so that we can "IPL" in approximately three seconds which is important to remaining "on-line". However, we took great care to localize these changes to the extent possible so that problems of later upgrading would be minimized.

All of these things combined to allow us to design and implement the original system in 18 months with 14 people. To this day only 20 people are assigned to the whole project even though this is indeed a very large and sophisticated system which provides accuracy and timeliness better than any other system we are aware of and provides transportation people the tools they really need and use in operating the railroad.

In summary, our approach can be outlined as follows:

1. The rail yard should not have to adapt its methods to the convenience of the computer system.
2. Rail yard actions should be as simple as possible requiring a minimum of training.
3. High centralization of difficult or error-prone tasks to permit better control and supervision.
4. Whenever possible, standard and proven hardware and software should be used.
5. All aspects of the design should be straightforward, modular and aimed at the basic needs.

While we would not claim that our design is the only proper or desirable one, since each system must be designed to the environment in which it must be implemented and operated, we do feel that the basic principles have been demonstrated to be feasible and practical and certainly, in the case of Southern, successful. Other roads, with different geographical layouts, different managerial philosophies and different situations may well find our approach unacceptable, as we would find theirs. This demonstrates only that there are possibly many good ways to solve this problem which is generally similar to many railroads.

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to approach a total management system. Optical character recognition is an aid to more accurate and timely input which could save the railroads untold millions in the costs of keypunching alone.

"But its benefits to the industry could be greatly enhanced with greater standardization of railway reports and documents—particularly the freight waybill. The hardware is available—greater standardization would give it a push.

"I look forward to the 4th International Railway Cybernetics Conference in Washington in April and hope that the railways user departments will be well represented. For management systems can only be successful if their specifications are created by the people who will use the output. Flooding an organization with reports that are not meaningful to the user departments become a wasteful expense that can quickly nullify the intangible benefits.

"The computer experts know the capabilities of the hardware—but only the users of the data developed can equate the very significant expense to the benefits derived."

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Belt Railway: Fast switch in Chicago

The Belt Railway of Chicago is one of the largest Class 1 switching carriers in the United States. The Belt operates a two-way rail car interchange facility which encompasses hundreds of miles of track, nineteen railroad carrier connecting points, more than four hundred industrial plant sidings, and a rail to water shipping connection point.

The Belt is jointly owned by twelve railroads serving most regions of the country. The owner railroads are: Atchison, Topeka & Santa Fe; Burlington Northern; Chesapeake & Ohio; Chicago & Eastern Illinois; Chicago, Rock Island & Pacific; Erie Lackawanna; Grand Trunk Western; Illinois Central Gulf; Louisville & Nashville; Norfolk & Western; Penn Central; Soo Line.

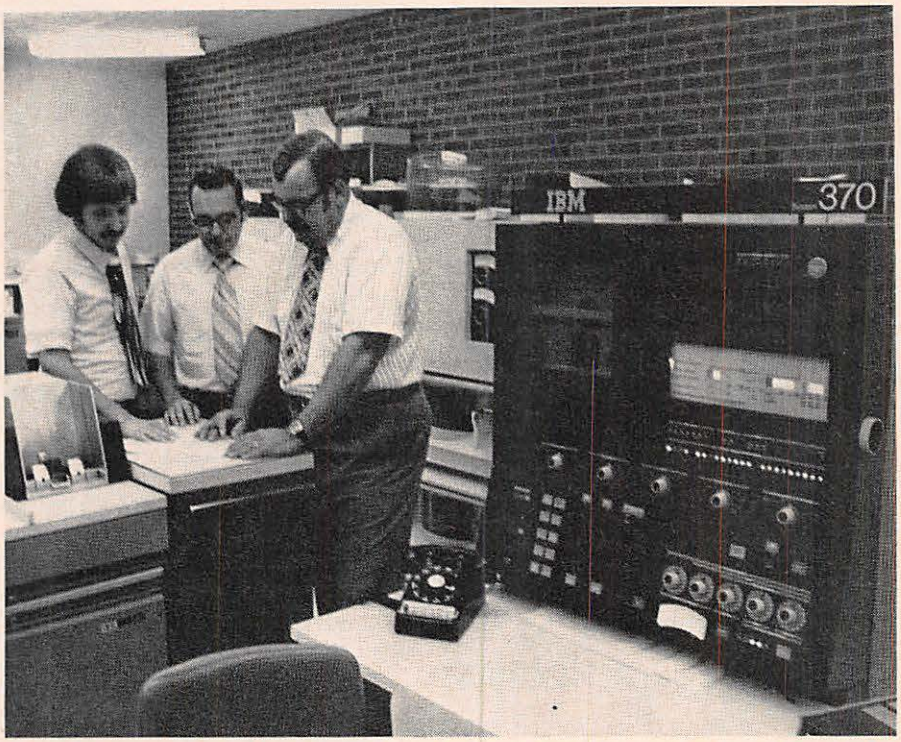
The Belt Railway has slashed rail car interchange time from days to hours. A computer car control system plays a big role in the service improvement.

Thousands of rail cars stream into the yards of the Chicago Belt Railway everyday. Some are delivered by Eastern railroads, others by Western roads. Most are headed for points beyond the huge Chicago railway hub, some for sidings at Chicago area industrial plants. All the freight cars have to be interchanged at the Belt's facilities in order to complete their journey.

The Belt Railway is one of the nation's busiest Class 1 switching carriers. Its job is to make sure that every car moves on towards its destination in the shortest possible time. This is a complex procedure involving receiving yards, departure yards and a maze of classification tracks. Not too long ago, the job took an average of 48 hours for each car interchange. Today, the interchange time has been slashed to an average of only 12 hours for a humping operation, and to only three hours where a "block train" interchange is involved. The block train bypasses the humping operation.

"This speedup in interchange time is directly attributable to a new car transfer concept and a remarkably effective computer-based car control system. It is especially important in a rail center like Chicago that handles a massive volume of train traffic," noted R. E. Dowdy, the Belt's young and innovative chief executive who took over the presidency in February 1972. "The sharp reduction in average interchange time has meant savings of many thousands of dollars for our owner railroads, and it goes a long way towards relieving the chronic congestion in the city's rail yards.

"The shortened switching interval—from the time an interchange car is delivered to our receiving yard by the inbound carrier until it is ready in our departure yard for haul by the outbound carrier—is fact, not promotional promise," Mr. Dowdy emphasized. "We are easily maintaining this transfer time with the 2,500 or so rail cars we now handle every day, and we can maintain it with the 5,000-plus cars a day we expect to be handling a year from now."



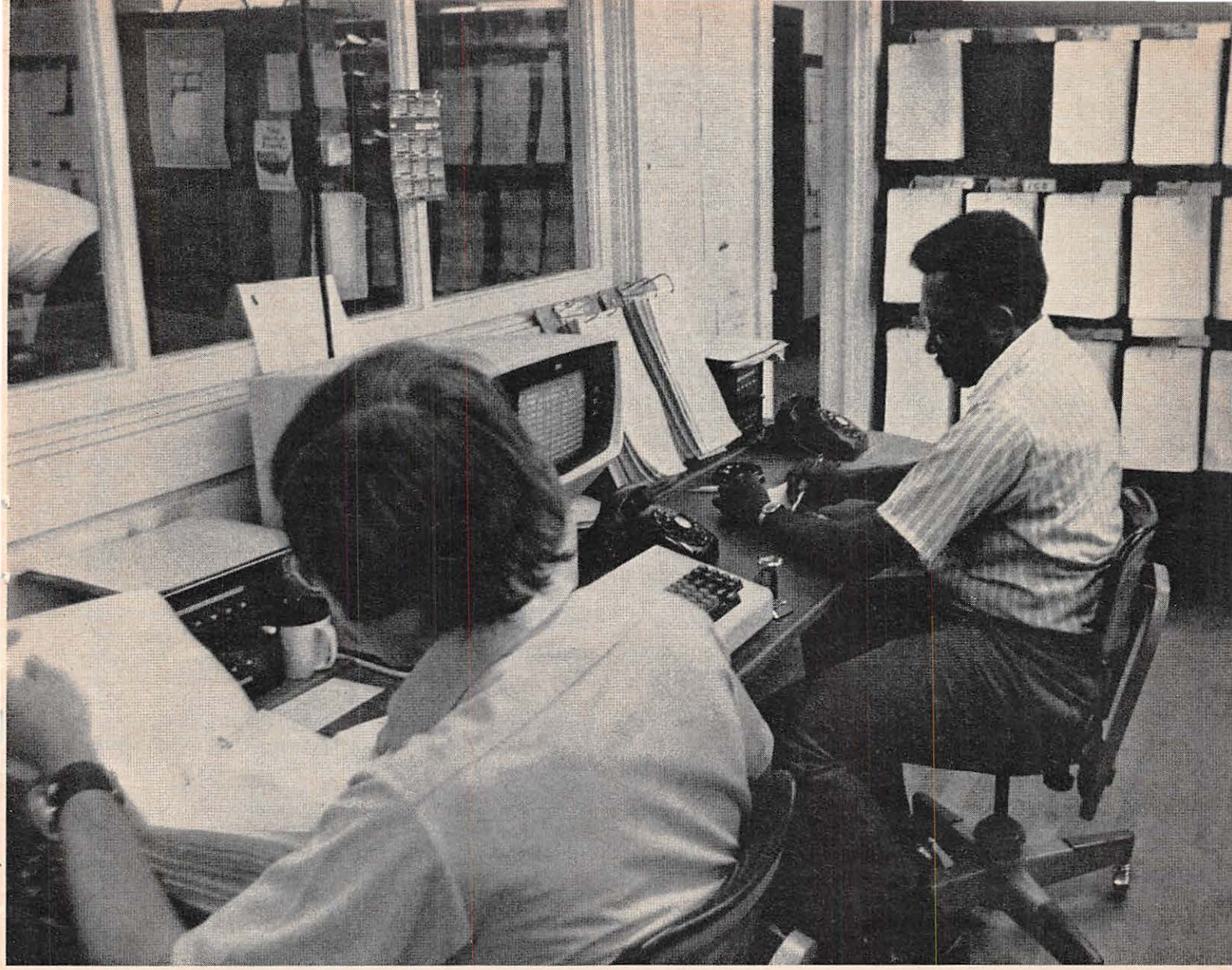
Ray Heger, director of data services (right), discusses operations of the IBM System/370 Model 135 with members of the computer room staff.

Personnel assigned to the railroad's service bureau use their IBM 3270 visual display terminal to check on car location and car arrival and departure times in response to carrier customer inquiries.

Two relatively new aspects of Belt Railway operations are given much of the credit for the marked service improvement that has been accomplished in a short time. One is the "block train" concept that was inaugurated by Mr. Dowdy late in 1972. Under this concept, each inbound carrier assembles at its own yards blocks of cars for the same interchange destination, makes these cars up into a block train and delivers the block train to the Belt receiving yard. Any miscellaneous interchange destination cars that might be included in the block train are detached and humped. The block cars pass right through to the appropriate departure yard.

The other significant element is the Belt Railway's effective computer system, built around a flexible IBM System/370 Model 135. In its primary car control function, the system uses online visual display terminals, typewriter terminals and card input devices that are located strategically throughout the Belt's sprawling facilities. The "online" units give Belt personnel at key operating points fast access to computer-stored information on rail cars, and permit them to update the computer files from locations all over the yard.

The computer records all car movements, from arrival to departure, and the timings of every interchange car; it also directs the humping of cars to their proper classification tracks and the assembly of cars for departure," explained Ray F. Heger, the Belt's director of data services. "If block train breakup or car interchange activity lags behind schedule, for example, the system generates an alert. It also identifies a car that requires special handling because of its contents (explosives, chemicals, or the like). Every



morning, the computer produces a summary that reflects the previous day's yard operations and flags the trainmaster's attention to any off-standard performance."

Belt Railway's car control system is activated each time there is delivery of an incoming train by an inbound carrier. A switching information clerk in the Belt's receiving yard office collects a waybill from the incoming train's conductor for each car. The clerk records the initials and numbers, the type of car, its contents, and a code showing the car's departure connection in train sequence.

After recording this information, the switching clerk can use a key punch in the receiving yard office to input the car identity data directly into the computer, or send the recorded information via pneumatic tube to the yard operations office. A single punched card is produced for each car. It is the key control document for every kind of car interchange transaction: from one Belt owner railroad to another, from an owner road to a non-owner road, or vice versa; from a railroad to an industrial plant siding.

Processing the car control card data, the System/370 Model 135 computer immediately sets up a record entry in its *car control master file*. This is the key file in the control system. It contains all of the identity and destination data for each car and records the movement of every car—the date and time it was received, the time it was "humped" and the number of the classification track onto which it was shunted. The master file also shows the time a car was pulled from the classification yard, the time it arrived at its departure yard connection point, and the time it departed coupled into an outbound carrier train. With a block train, the master record shows the time the block cars were received, and the time they were pulled from the receiving yard to the departure yard.

Another important master record file maintained by the System/370 Model 135 computer is the *train log*, which is updated by header cards that accompany the car control card data. The log identifies each inbound block train, the delivery railroad, shows the number of cars in the train and records the arrival time. A third master record set is the *interchange file*. It continuously records what inbound railroad delivers which interchange car to which outbound road. This is essential, of course, for inbound/outbound carrier reporting and for billing and per diem charge apportionments.

The car control, train log and interchange master files are updated by the Belt system as car movements occur within the Belt railway facilities. The medium that notifies the computer of these movements always is the car control punch card; the cards are stored in train sets and car arrival sequence in the yard operations office.

All car interchange activity is initiated from the operations office. The nerve center for yard operations, it is equipped with a variety of IBM computer communications equipment—a 3270 visual display terminal, a 2770 high-speed card reader, and two 1050 typewriter terminals. The Belt Railway

Bunch Woodcox, console opeator (seated), and Larry Shefcik, manager of data processing, are working in Belt Railway's computer room.

operates a fully duplexed switching facility—one for east to west traffic, the other for west to east trains. The duplexed switching networks have identical facilities, but they are geared for movement in opposite directions. The receiving yards accept the inbound trains. The humping yards are used to break up the trains. The classification yards (with about 50 separate tracks each) store the cars assigned to particular interchange departure points. The departure yards are where trains are made up for haul by outbound carriers. One of the 1050 terminals transmits information relating to east to west car movements; the other serves west to east traffic flow.

When the yardmaster is ready to "hump" a train held in either receiving yard, a 1050 terminal is used to notify the computer. The System/370 Model 135 retrieves the car control information from the master file, and produces a complete "hump list" on the terminal. This list tells the yardmaster exactly how to break up the train, and identifies the classification track to which each car should be shunted. The list identifies each car in train sequence, the kind of car and its contents, and includes any special car-handling instructions.

One of the Belt Railway's powerful switching locomotives hauls the train out of the receiving yard, and pushes it up the hump to the uncoupling point. Using the computer-produced hump list as a guide, the yardmaster directs the uncoupling of the cars, which then are allowed to roll down the long hump decline towards the classification yard. The rolling cars are guided from the humping track to their assigned classification tracks by switching operators who are in a series of six hump towers. Overlooking the approaches to the classification yard, each of the hump towers is equipped with a 1050 computer terminal, as is the hump yardmaster's tower that oversees the entire operation.

The entire humping operation is fast and efficient. The yardmaster simply follows the hump list to break down the train in car sequence; the tower operators use the list to guide the cars onto the correct classification track. One of the hump tower operators put it this way: "With the help of the computer system, we can now move cars over the hump and onto the right holding track with clockwork precision."

When the humping of the train is accomplished, the yard operations office signals the computer. The System/370 Model 135 updates the train log and the car control master file records to reflect the hump time and records the classification track location of each of the interchange cars. The computer prints back on the yardmaster's and the hump towers' 1050 terminals sequence lists of the cars that are currently standing on each of 90 different classification tracks. This action completes the inbound interchange car movement cycle.

The outbound interchange cycle begins with the yardmaster's instructions to move a block of cars from a given classification track. The cars are coupled together and a "pull down engine" switches them to the departure yard. Information about the pull-down movement and the timing is transmitted to the computer at electronic speed; the car control card data is entered through the operations office high-speed card reader. When the engine and crew from the outbound carrier road arrives at the departure yard, the crew conductor receives the waybills for each car in the outbound train. When the train departs, the system is updated by way of the 1050 terminals at each of the departure yard offices.

The car control, train log and interchange master file records are updated to show the current movements. The car control record entry remains in the file until it is erased to make file space available for new rail car entries. At any time, inquiries can be made into the master record files via the IBM 3270 visual display units. Visual display terminals in the yard operations office and in the Belt service bureau are used to check train or car arrival times, car track locations, movement timings and departure times in response to carrier and carrier customer inquiries, and for operations scheduling purposes. A 3270 is also located in the Belt Railway's accounting department for use in checking customer charges, and per diem apportionments between carriers.

The Belt's computer car control system is operational 24 hours a day. At the end of each work period, the computer produces a summary of car interchange activity that has taken place by type of car, inbound and outbound carriers, and arrival and departure tracks. Each morning, it generates a detention report, listing all cars that arrived the previous day and are still awaiting interchange. The detention listing serves as an expedite document. Interchange car reports for both inbound and outbound carrier railroads are produced by the system, and basic accounting information is derived from the car control master records.

President Bob Dowdy is quick to emphasize that he is "not wed to the old ways of doing things," But, at age 38, he already has a substantial railroading career behind him, including a term as president of the Chicago & Western Indiana. He is a strong believer in the necessity for a healthy, viable railroad system.

"One way to contribute to the vitality of the railroad industry is to reduce the lost time, and the heavy expense burden—not to mention the fuel consumption—involved in the interchange or rail cars at the nation's major rail centers," Mr. Dowdy pointed out. "That is what we are doing at the Belt Railway and we couldn't hope to do it without the support of our highly efficient computer system."

Wanted: New standards for AFO

Little research has been done to develop a scheme for a "worst case shunt," to be used for testing and alignment of AFO track circuits. In the past, the .06 ohm shunt has been quite adequate when applied to track circuits of the DC, AC power frequency and coded variety. With the advent of AFO track circuits many problems have been presented since impedance is the primary attenuating factor, not resistance. With a given shunt, the resistance will remain constant, but as the audio frequency goes up, the impedance goes up, thus less attenuation. If the standard .06 ohm shunt is used for aligning AFO track circuits, the impedance is affected by frequency, track conditions and ballast conditions.

This spring General Railway Signal Co. will start an extensive project to compile the information needed for developing new standards and new equipment which will make the alignment of AFO track circuits more accurate.

Klaus Frielinghaus (senior research engineer for GRS) has gathered a great deal of information concerning the characteristics of various track conditions and how the levels of audio frequencies are affected. Although Mr. Frielinghaus does not suggest any specific standards of new procedures for dealing with AFO track circuits, he does give some good insight to the problems which manufacturers and signal personnel are confronting with AFO track circuits. The following paper entitled "Tradeoffs in the Design of Audio Frequency Track Circuits" was presented by Mr. Frielinghaus at the recent AAR C&S Section annual meeting in New York.

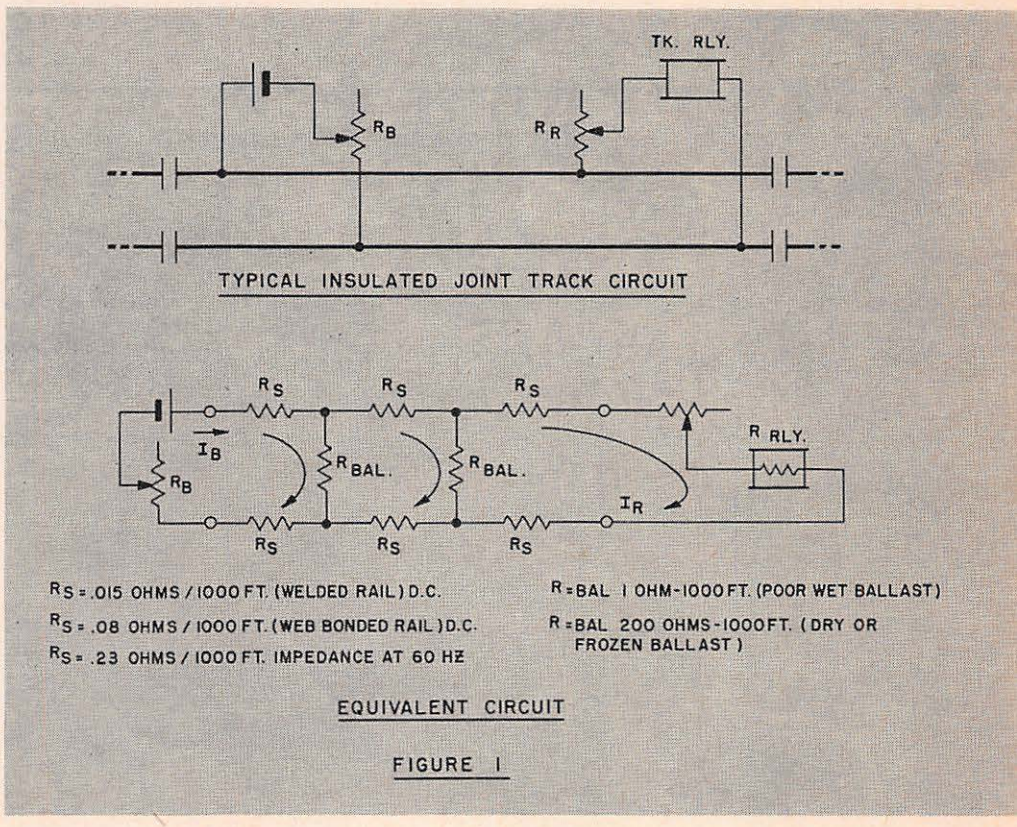


FIGURE 1

During the first 75 years since Dr. William Robinson patented the closed circuit principle track circuit in 1872, much work was done to perfect and refine insulated joint track circuits of the DC, AC power frequency and coded variety. Despite the many years of development and application, there are still some puzzling track circuit phenomena that are difficult to explain or analyze.

In the 1950's the first audio frequency jointless track circuits were developed with the availability of reliable industrial transistors. At first it appeared that these new audio frequency track circuits had many advantages over the former insulated joint track circuits, such as no requirements for insulated joints, apparent compatibility with DC and AC electric propulsion, overlapping and multiple track circuit capability, multiple receiver capability, ease of installation and adjustment, and immunity to foreign currents and signals. As these jointless audio frequency track circuits came into general use, many problems, not at first readily apparent, were uncovered which resulted in some acute application constraints; and new problems are still evolving.

In retrospect, it appears that the number of track circuit design and application problems of the insulated joint track circuits are few in comparison to the problems related to audio frequency jointless track circuits.

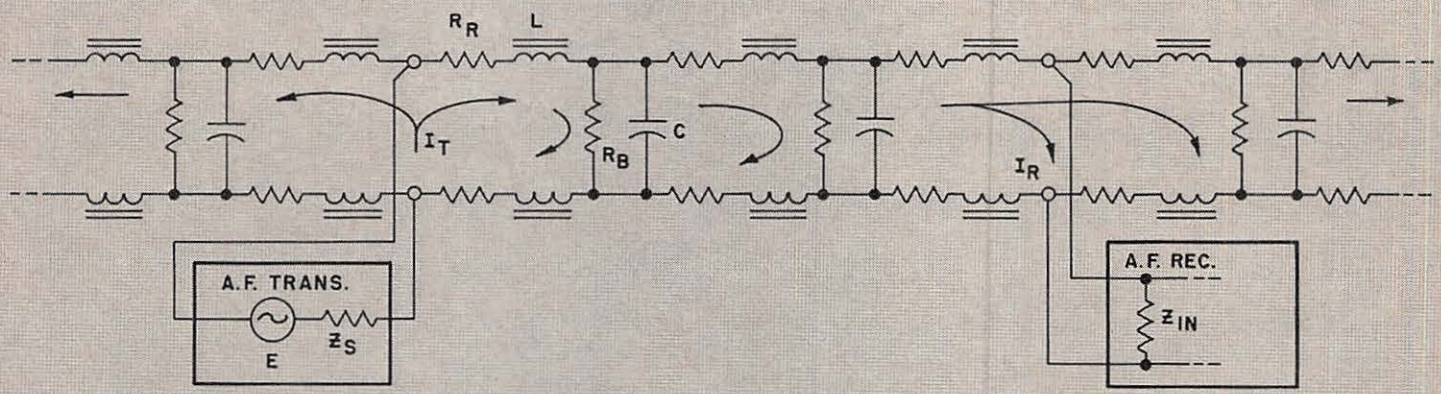
The main new factors of audio frequency track circuits that complicate their application are increased losses, mainly due to the series inductive rail impedance, which is substantial at audio frequencies, and the loss of efficient isolation previously provided by the insulated joints.

Referring to the typical voltage sensing audio frequency track circuit shown in Figure 2, which shows a number of differences over the insulated joint track circuit, illustrated in Figure 1. First, the transmitter output is split two ways, with one half of the output energy flowing in the track circuit toward the receiver, and the other half flowing in the track section away from the track circuit—energy which is lost unless this happens to be a centerfed track circuit configuration. Second, the receiver is essentially bridged across the track with only part of the track circuit signal current being received by the AF receiver, with the remainder being lost in the continuing track. The continuing track past the receiver also acts as a load in parallel with the receiver, which varies with ballast resistance changes and the approaching shunting effect of a train, thus changing the load on the receiver. The same is true at the transmit end. Third, the series rail inductive reactance predominates over the series rail resistance at audio frequencies and rapidly increases track signal attenuation throughout the audio frequency range.

Figure 3 provides an idea of the magnitude of the series rail inductive impedance as related to the AC and DC rail resistance vs. frequency. At 500 Hz, the series inductive impedance is about 25 times greater, while at 5000 Hz it rises to 225 times greater than the DC rail resistance, thus rapidly increasing signal attenuation with increasing track circuit frequency.

Fourth, the leakage of the shunt capacitance, shown in Figure 2, becomes noticeable at audio frequencies, especially at high values of ballast resistance and high frequencies. Typically, the shunt capacitive impedance is 30

TYPICAL JOINTLESS AUDIO FREQUENCY TRACK CIRCUIT



EQUIVALENT CIRCUIT

FIGURE 2

times greater than the ballast resistance at 100 Hz and 5 ohms ballast, but at 10,000 Hz and 200 ohms ballast this shunt capacitive impedance is about equal to the ballast resistance.

These last two factors substantially reduce the maximum length of audio frequency track circuits in relation to insulated joint DC and AC track circuits and, since the series rail inductive impedance and shunt rail capacitive impedance become more prominent with increasing frequency, maximum operating track circuit lengths decrease with frequency. One's first reaction upon seeing that the received signal has been attenuated below the minimum operating level of the audio frequency receiver is to consider increasing the transmitted power or the receiver gain until it is sufficient to pick up the track relay. If the track circuit were just a communication link, this may be a valid action, but since a track circuit is also, and more importantly, a train detection system which must operate correctly within two boundary conditions, this becomes an invalid and unsafe action. One boundary condition is the received voltage at the lowest expected ballast resistance with no train influencing the track circuit. The other condition is the received voltage at the maximum ballast resistance with an .06 ohm shunt at the receiver or transmitter. For safe operation of the track circuit, the first condition must result in a higher received voltage than the second condition, and the receiver gain must be set to just pick up the track relay at a received

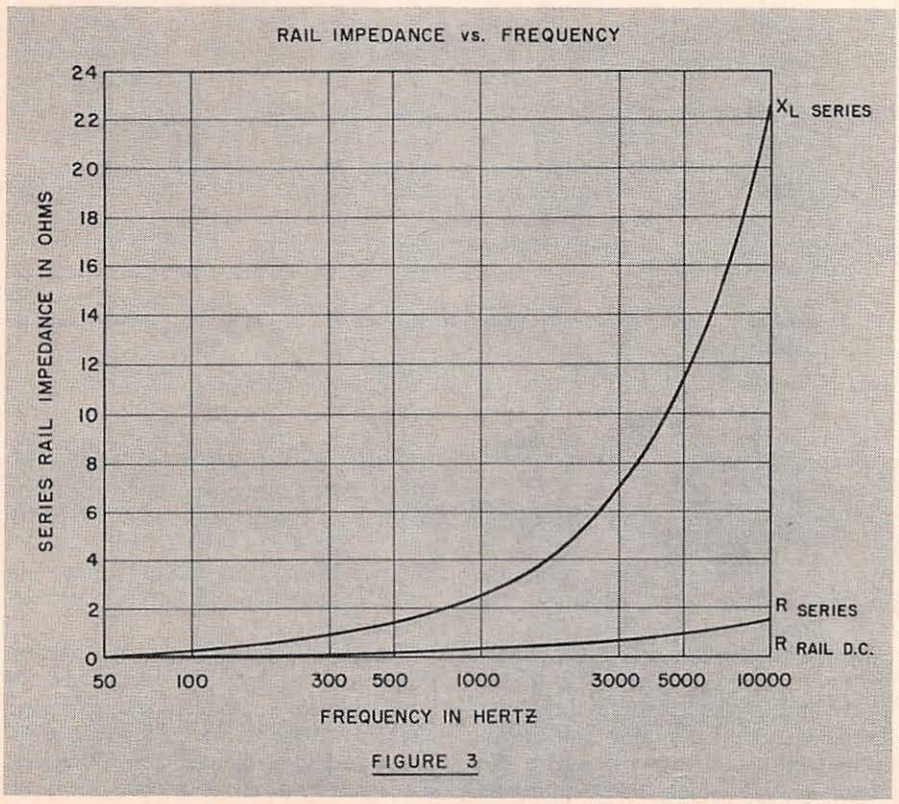


FIGURE 3

voltage that is between these two boundary conditions.

Figure 4, a family of curves for different ballast resistances and no train shunt, shows relative receiver voltage vs. track circuit length.

A single curve across the lower end shows relative receive voltage vs. track circuit length for a track with a ballast resistance of 200 ohms in 1000 feet and a .06-ohm shunt at the transmitter or receiver. As shown, the figure is based on a track circuit frequency of 1150 Hz on 90 lb. rail. Let us consider a typical track circuit installation in an area where the ballast is known not to drop below 5 ohms in 1000 feet. For a maximum ballast resistance of 200 ohms, a safe track circuit operating range is shown by unshaded area bounded on the top by the 5 ohm ballast and no shunt signal attenuation curve, and on the bottom by the 200 ohm ballast and .06 ohm shunt curve. Note that at approximately 6900 feet these two curves cross over. This crossover point indicates the theoretical maximum track circuit length for the given conditions of ballast range, frequency, rail size, equipment impedance, and shunt resistance value. It was indicated earlier that for each set of fixed conditions there was a maximum track circuit length, and that increasing the output of the transmitter or gain of the receiver could not increase the theoretical maximum track circuit length. These two curves indicate why—because an increase in transmitter output raises both curves simultaneously and there is no horizontal shift of the crossover point in the two curves. Increasing the receiver gain does the opposite. It lowers the two curves, with again no shift in the horizontal position of the crossover point. For a given set of fixed conditions such as frequency, equipment impedance, etc, the only way to increase the theoretical maximum track circuit length is to reduce the range of ballast resistance over which the circuit has to operate safely. For example, if the ballast and ties are maintained so that the minimum ballast does not drop below 10 ohms in 1000 feet, the upper curve for the safe operating zone becomes the 10-ohm ballast, no shunt curve, and now the crossover point has shifted to the right to approximately 10,800 feet. Therefore, the maximum theoretical track circuit length is 10,800 feet if the ballast resistance does not exceed 200 ohms or drop below 10 ohms.

On the other hand, if the ballast is known to drop to 2 ohms in 1000 feet, theoretical maximum track circuit length drops down to 3500 feet.

Note, if the ballast resistance range is reduced by limiting the maximum ballast resistance to something less than

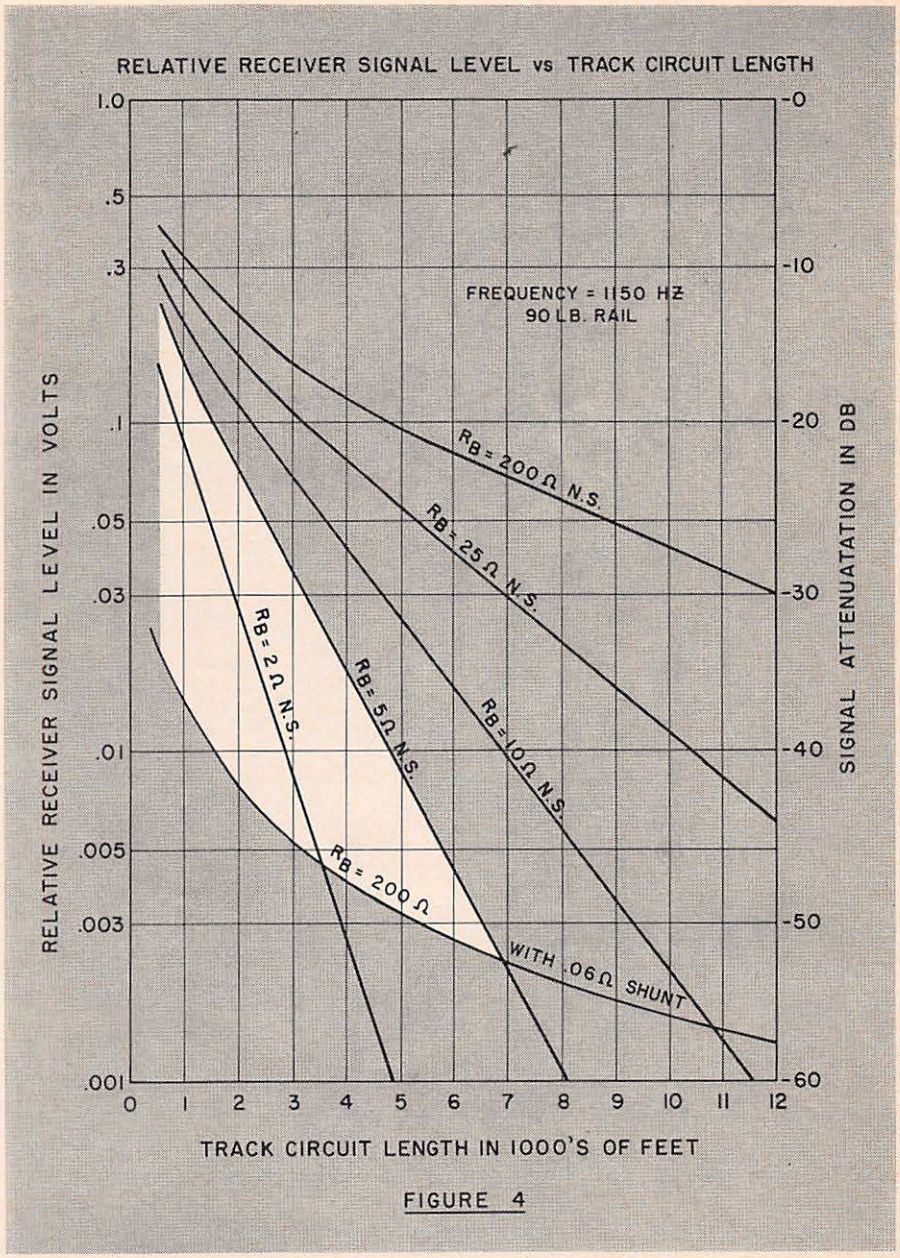


FIGURE 4

200 ohms in 1000 feet, the lower boundary high ballast curve with a .06 ohm shunt would drop down slightly, causing the crossover of the two curves to shift to the right, thus also increasing the maximum theoretical track circuit length.

This track circuit length analysis is valid for audio frequency track circuits and for DC and AC power frequency track circuits. Because the attenuation at DC is so much less, the two operating condition curves cross over at 20,000 to 40,000 feet. Since DC and AC track relays are usually designed with a 50% drop to pick differential, these maximum track circuit lengths were not realized until coded track circuits were developed, and then only partially.

In Figure 5 we see a series of safe operating zones for a number of frequencies. In each case, the upper boundary line represents 5 ohm ballast, no shunt attenuation curve. The lower boundary line represents 200 ohm ballast with a .06 ohm shunt attenuation curve. The figure illustrates the reduction in theoretical maximum track circuit length and signal level versus frequency. Note that at frequencies above 3000 Hz the track circuit length reduction rate decreases, but the receiver signal level reduces at a greater rate indicating that the received signal level might be the practical limiting factor that determines the actual maximum track circuit length for the higher frequencies. It is only under this condition that the track circuit length may be extended by increasing the transmitted output level.

Wide margin adjustment

Figure 6 is an expanded version of unshaded area in Figure 4. This figure

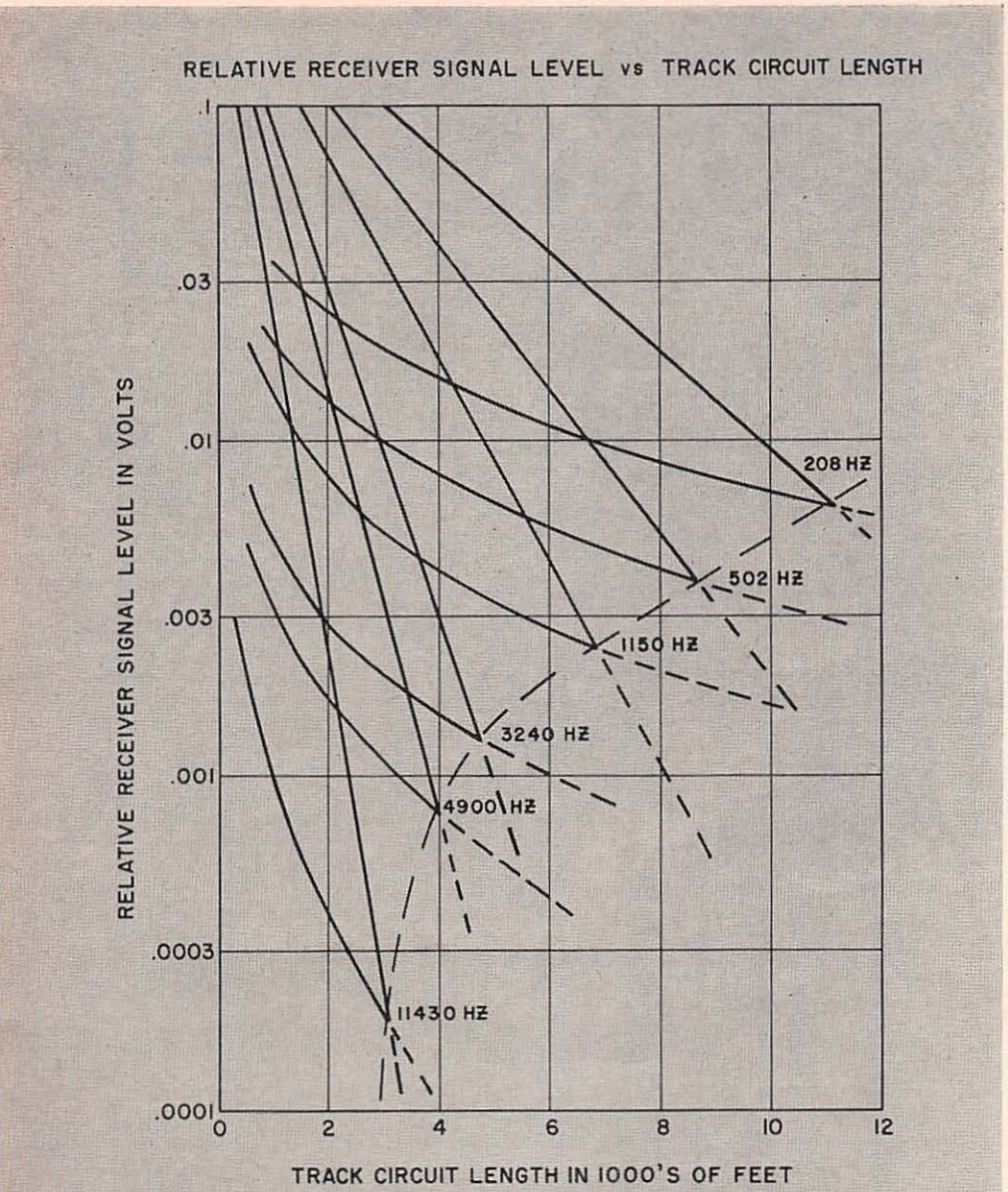


FIGURE 5

illustrates some audio frequency track circuit adjustment considerations. Since electronic track circuit receivers exhibit very little hysteresis, the track relay operated by this receiver picks up and drops with only a small change in input signal voltage. Therefore, the relay operate point can be considered to be a single input voltage trip point controlled by the receiver gain control. The widest margin operating point is one that represents a receiver voltage that is midway between the voltages designated by the upper and lower boundary curves. Since the vertical voltage axis in Figure 6 is logarithmic and not linear, the "Wide Margin Adjustment" appears to be offset toward the upper boundary curve, but the voltage values it represents are actually the mean or mid value between the upper and lower curve.

In many types of audio frequency track circuit equipment, the output level of the transmitter may vary directly with the battery supply voltage. In the receiver, this is not a problem because feedback in the receiver amplifier holds the gain constant despite battery supply voltage changes. To protect against the variation of transmitter output with battery voltage variation, a ±25% guard band is incorporated around the adjustment line. These guard band lines are carried down to the crossover point. When the guard band comes within 10% of the upper and lower boundary curve, the maximum practical track circuit length is reached. The 10% region is an additional safety margin to take care of variations in equipment and track attenuation characteristics. With this type of adjustment, when it is used on shorter and shorter track circuit lengths, its margins from the upper and lower boundary condition curves become larger. Thus, for shorter track circuit lengths the adjustment becomes less critical and is tolerant of large variations in track characteristics, uncertainty in ballast resistance determinations and equipment and battery variation. This so called "Wide Margin Adjustment" has one disadvantage and that is a substantial increase in the preshunt distance of the track circuit as the track circuit becomes shorter for that frequency. Because insulated joints are not used with audio frequency track circuits, common voltage sensing audio frequency track circuits begin to sense the presence of a train before it arrives at the track connection point of the equipment. As a result, they shunt or drop the track relay before the train actually arrives at the track connection point. The distance ahead of the track connection point where the track relay is actually dropped by the presence of a train is known as the preshunt distance. The same phenomenon occurs as a train leaves a track circuit; this shunting point distance beyond the track connection point is sometimes referred to as the extended shunt distance. If the long preshunt and extended shunt distance, which result from the "Wide Margin Adjustment" procedure on short track circuits, cannot be tolerated, a so called "Constant Shunting Definition Adjustment" can be used which is also shown in Figure 6. This track circuit adjustment is one where the track circuit relay pickup voltage is maintained a constant 35% above the lower boundary condition line. The 35% consists of a 25% region to cover for transmitter battery voltage reduction and a 10% border safety margin. With this type of adjustment, the track circuit preshunt and extended shunt distance remains essentially constant for all track circuit lengths within the limit of the maximum practical length at that frequency at a given ballast resistance condition. The disadvantages of this type of adjustment are: a reduction in shunting sensitivity, a reduction in inter-rail voltage requiring high transmitter output level or higher receiver gain, and only a constant 10% safety margin in the adjustment from the lower boundary condition curve for all track circuit lengths. Note, that with both types of adjustment, only a 5500-foot maximum track circuit can be realized at 1150 Hz. This maximum track circuit length can be achieved if the transmitter output and receiver gain is sufficient to pick up the track relay at the level indicated by the crossover of the two adjustment lines. The receiver signal levels shown on the vertical axis are relative to an open circuit transmitter voltage of one volt and represent about ⅛ of a watt transmitter output for the voltage values shown in Figure 6. For actual receive voltage values, the verti-

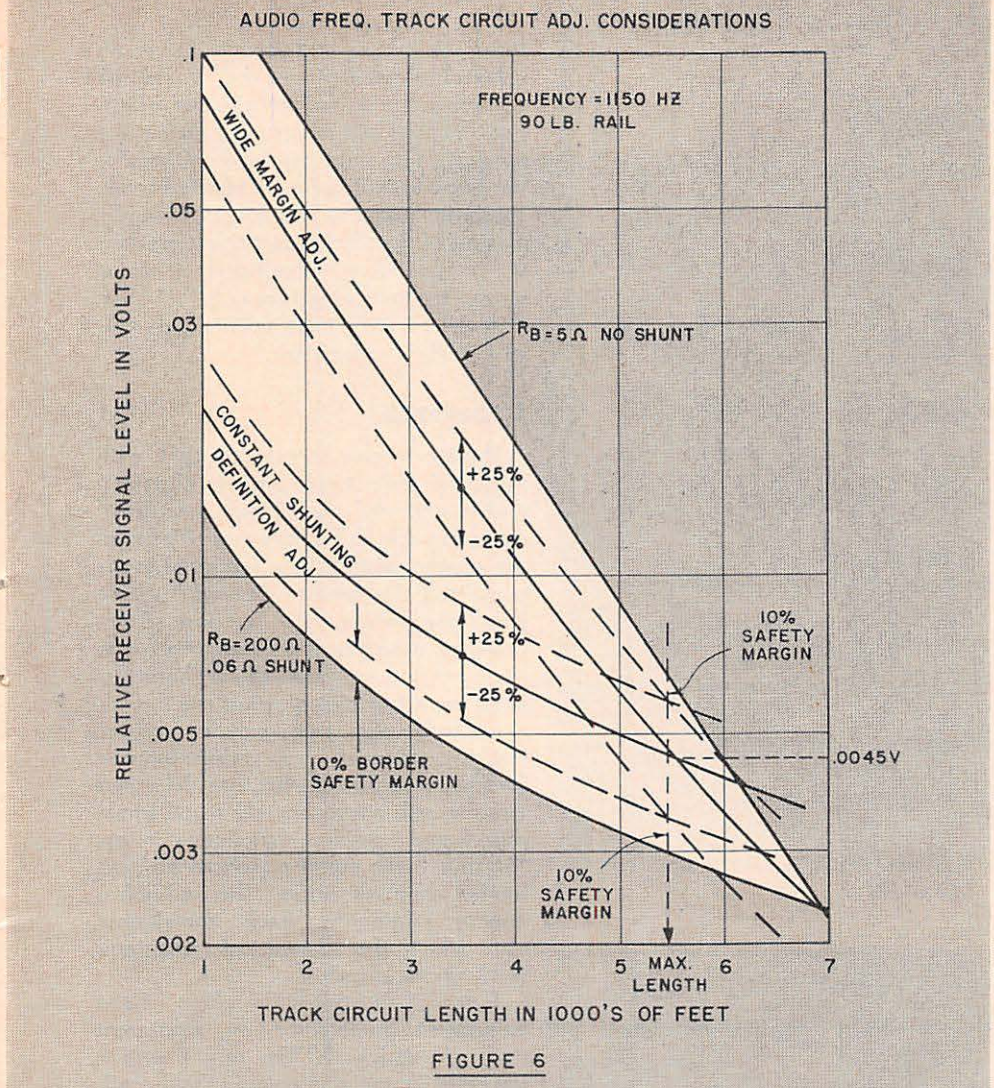


FIGURE 6

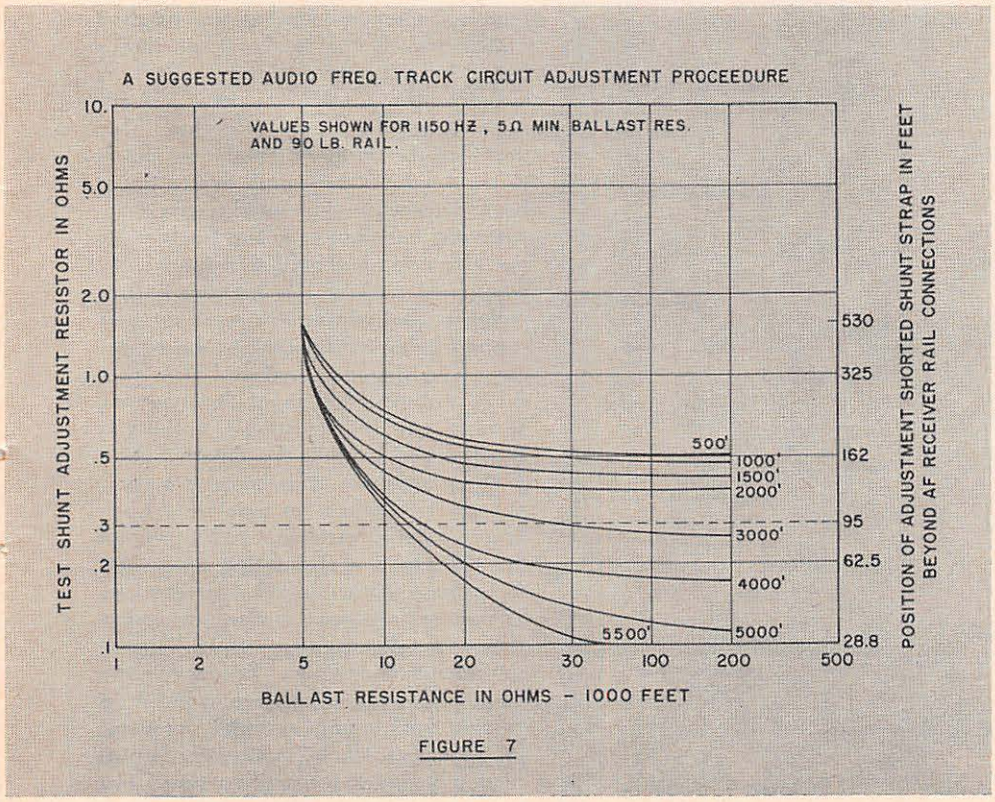


FIGURE 7

cal voltage scale is multiplied by approximately 2 for a ½ watt transmitter output, by 3 for a 1 watt transmitter output, and by 6 for a 5 watt transmitter output.

If we consider the actual values of received signal levels, shown on the vertical scale, the receiver sensitivity would have to be such as to pick up the track relay with .0045 volt at the receiver track terminals. If the maximum receiver sensitivity were only .01 volt, then the maximum operable track circuit length with the "Wide Margin Adjustment" would only be 4100 feet, and for the "Constant Shunting Definition Adjustment" would be 2400 feet. It is only in this instance that increasing the transmitter output level will increase the maximum operable track circuit length, but then only to the practical maximum length of 5500 feet set by the frequency of 1150 Hz. We have discussed track circuit adjustment considerations, but how do users of audio frequency track circuit equipment effect this adjustment in a simple manner.

Figure 7 is a track circuit adjustment scheme for GRS audio frequency track circuit equipment. The figure shows a family of curves which relate a track circuit adjustment test shunt resistor value versus ballast resistance for a number of different track circuit lengths. The curves are only valid for an 1150 Hz track circuit, where the minimum track ballast resistance is 5 ohms, and provide the so-called "Wide Margin Adjustment" that was described by the previous figure. By mathematical means and actual field measurements, test receiver shunting resistance values have been derived for different ballast resistances and track circuit lengths that will cause the receiver input voltage to be the same as was indicated on the curve for the "Wide Margin Adjustment" at that track circuit length. Now the receiver gain is adjusted to just pick up the track relay, and the test shunt resistor is removed. This completes the track circuit adjustment procedure, which is totally independent of the transmitter output level and permits correctly adjusting a track circuit at any existing ballast resistance condition. To illustrate an example of this procedure, assume we want to set up and adjust a 3000 foot track circuit. First, a ballast resistance measurement is made. Let us assume it is 30 ohms in 1000 feet. The curve shows that a .3 ohm test shunt resistor must be connected across the track connections of the receiver to provide an inter-rail voltage at the receiver that is midway between the 5 ohm ballast, no shunt voltage and the 200 ohm ballast, .06 ohm shunt voltage. Now the receiver gain is adjusted to just pick up the track relay, and the .3 ohm test shunt resistor is removed, completing

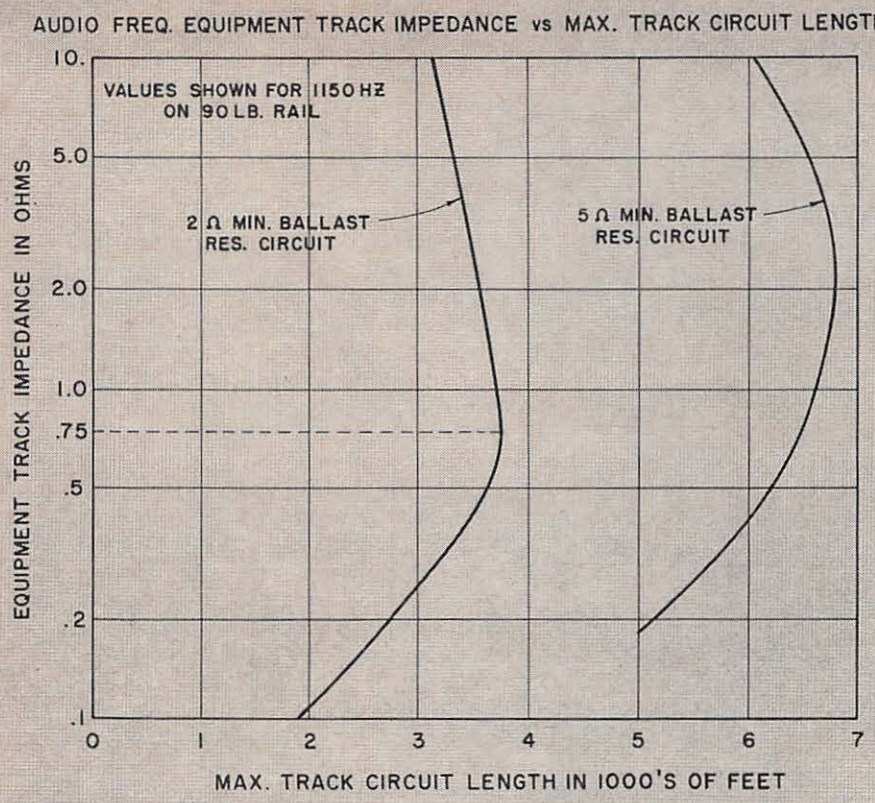


FIGURE 8

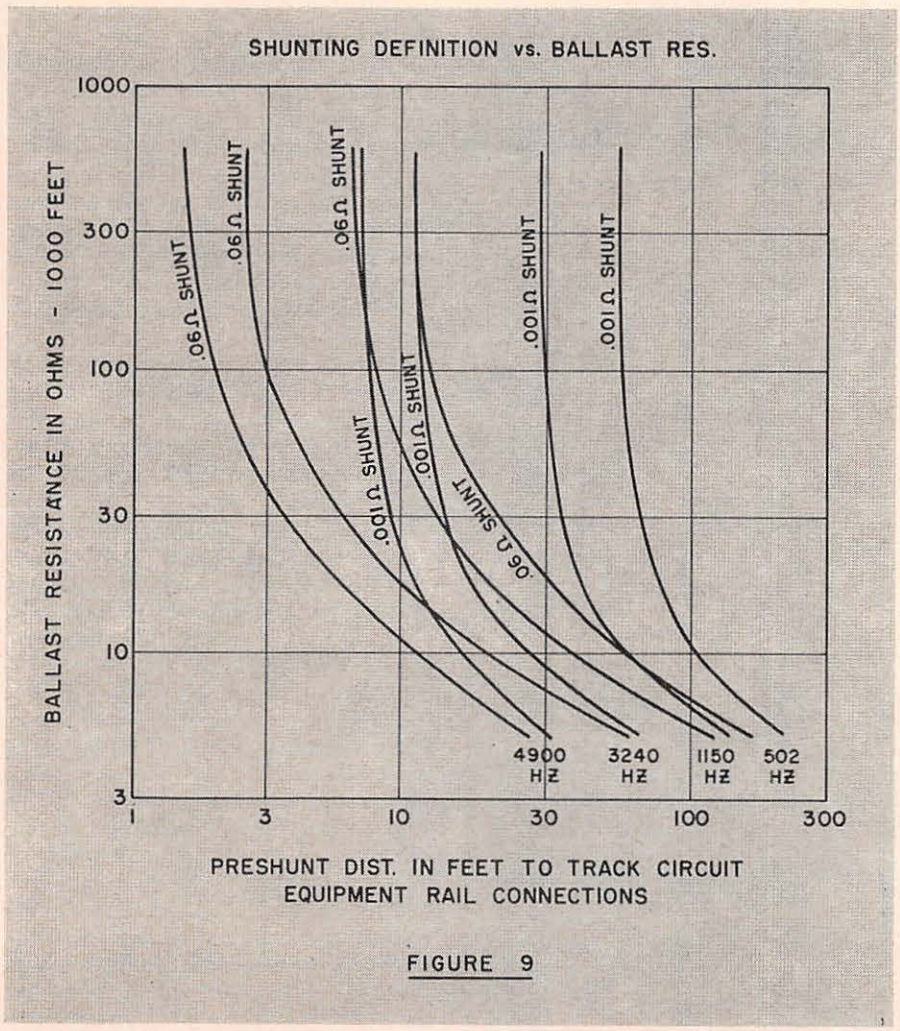


FIGURE 9

the track circuit adjustment. As an alternate adjustment means, a shorted section of track can be used to substitute for the test shunt resistor at the receiver. The right-hand side of the figure is calibrated in feet of shorted track. From our previous adjustment example, instead of the .3 ohm test shunt resistor, we could have substituted a shunt strap, located approximately 95 feet past the receiver track connections outside of the track circuit.

Impedance

Earlier it was mentioned that with insulated joint track circuits the feed and receive end impedances are adjusted to provide different types of operating characteristics. The insulated joints permitted this facility, but when these joints are removed this freedom of impedance adjustment is lost. Since the preshunt and extended shunt characteristics are a function of series rail impedance and audio frequency equipment track impedances, most ordinary audio frequency track circuits are balanced circuits with approximately equal transmitter and receiver impedances in order to achieve equal pre-shunt and extended shunt distances. The audio frequency equipment track impedances also affect the theoretical maximum track circuit length.

Figure 8 illustrates the effect of the equipment impedance on maximum track circuit length. The curves are for an 1150 Hz track circuit on 90 lb. rail. With a 5 ohm minimum ballast resistance adjustment, the maximum track circuit length is achieved with approximately 2 ohms transmitter and receiver impedance. If the track circuit is adjusted for a 2 ohm minimum ballast resistance, the ideal equipment impedance is approximately .75 ohm. This provides the proper impedance match to the track for maximum power transfer and therefore, is related to the characteristic impedance of the track at its worst or minimum ballast resistance. As mentioned earlier, the equipment impedance also affects the preshunt and extended shunt distances. As the equipment impedance is reduced, the preshunt and extended shunt distances are reduced, but the shunting sensitivity is also reduced, so that the determination of the equipment impedance is a compromise depending on maximum track circuit length, preshunt and extended shunt distance, and shunting sensitivity. Since these factors are all dependent on frequency, frequency is also a consideration in determining track circuit equipment impedance. Because audio frequency track circuits are overlaid on existing track equipment and other audio frequency track circuits, the equipment impedance is usually a tuned im-

pedance. It is at its designed value only at its carrier frequency and rises rapidly outside of this frequency so as not to affect the operation of other track equipment.

Figure 9 illustrates the effect of ballast resistance on the preshunt and/or extended shunt distances for different frequencies in the audio frequency track circuit range.

The preshunt distance is inversely proportional to the series rail impedance, frequency and ballast resistance. At low ballast, the presence of a train is detected well ahead of the point where the track circuit equipment rail connections are located. The variation in preshunt distance, over the ballast range shown, is approximately 15 to 1 for a .06 ohm shunting train and about 4 to 1 for a .001 ohm shunting train. Note that poorer shunting trains shunt closer to the track circuit equipment rail connections than good shunting trains. The added preshunt distance for a good shunting train is the length of series track impedance at the frequency which equals .06 ohm.

The curve in Figure 10 illustrates the preshunt extension when going from a .06 ohm shunt to a .001 ohm shunt and, as just mentioned, it represents the length of shorted track that equals .06 ohm impedance. At 500 Hz, this distance is approximately 45 feet and at 5000 Hz, it is reduced to 5 feet.

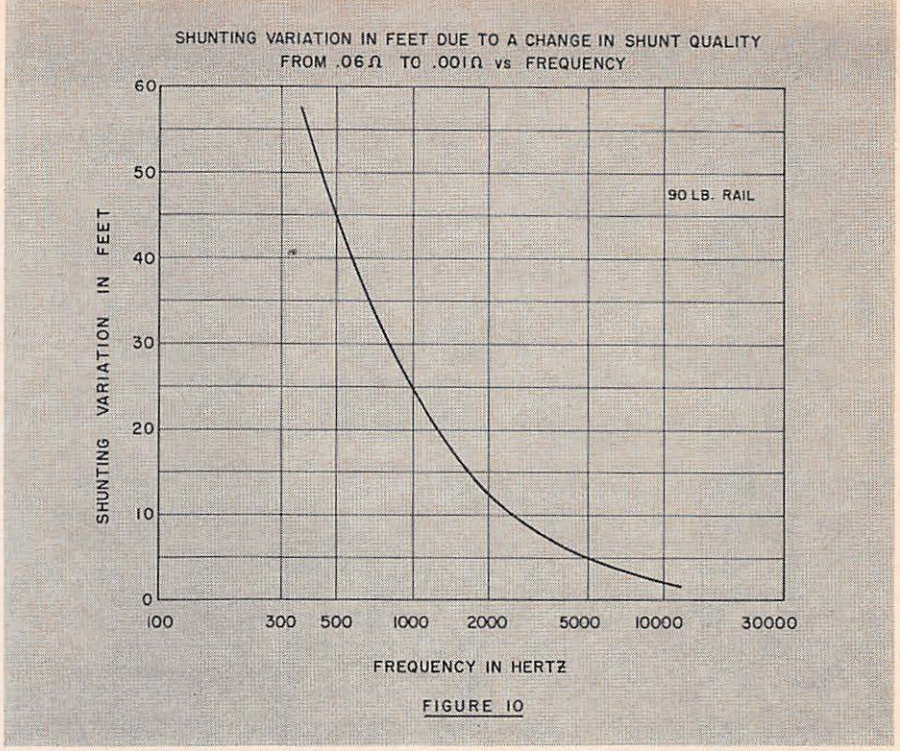


FIGURE 10

Research Needed

Now we have come to a very important subject where there has been little published data available. What is the shunting characteristic of a train at audio frequencies? Does the ionization voltage problem exist at audio frequencies? Is the .06 ohm standard minimum shunt set up by the AAR relevant at audio frequencies? We have done some investigation in this area and plan to do much more.

Figure 11 indicates the impedance of several types of shunting devices that are used in evaluating, testing, and adjusting track circuits as related to frequency. The GRS standard .06 ohm shunt resistor maintains its impedance up to 10,000 Hz at the same value as the DC value, indicating negligible inductance. The shorted shunt strap rises linearly in impedance with frequency from a DC value of 1 milliohm to an

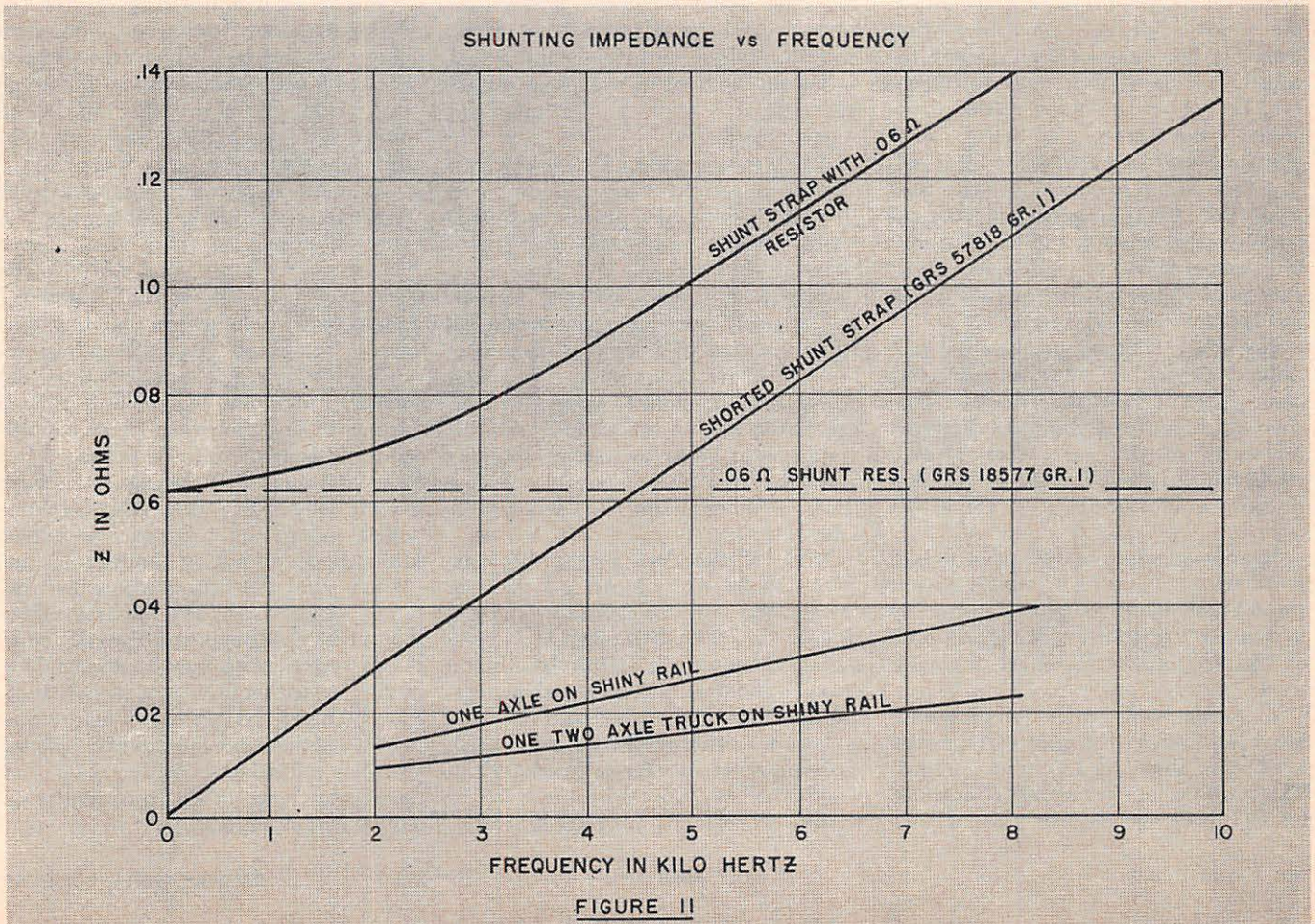


FIGURE 11

SUMMARY OF AUDIO FREQ. EQUIPMENT DESIGN TRADE-OFF EFFECTS

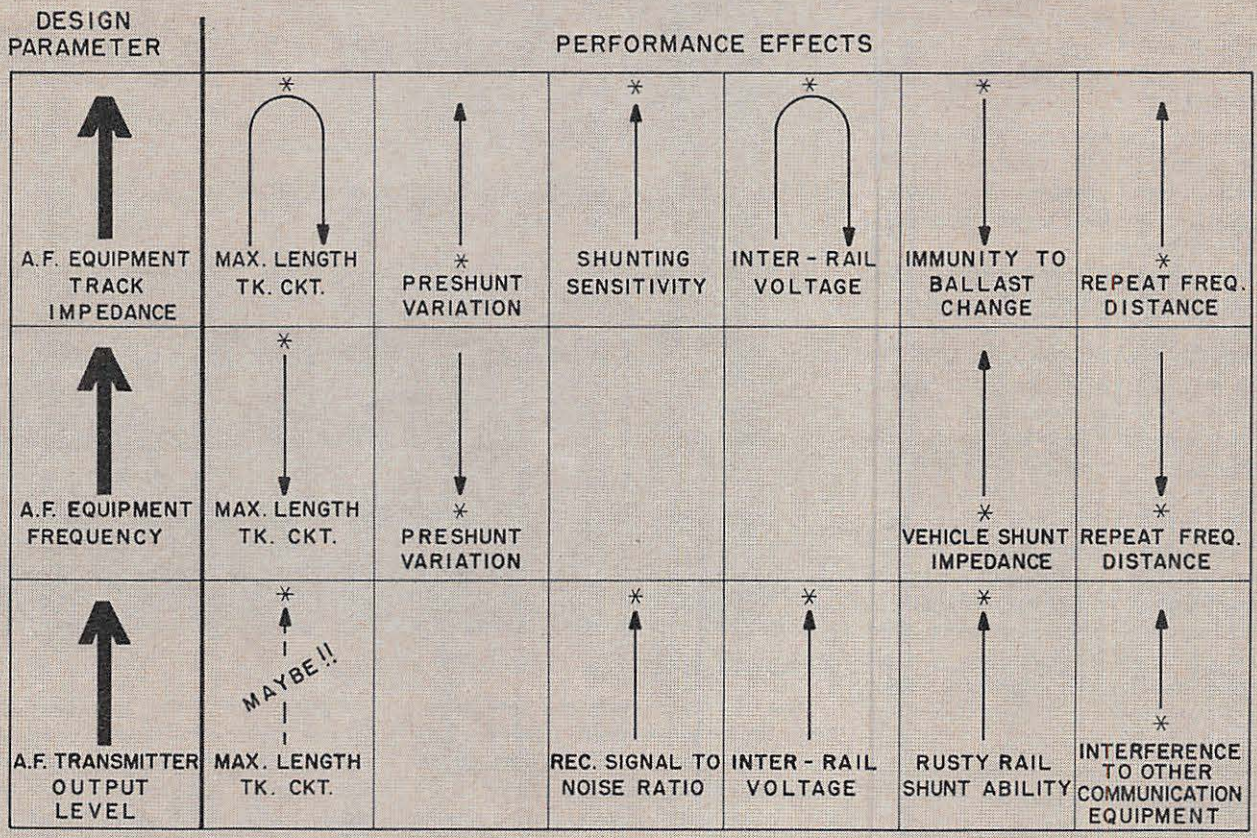


FIGURE 12

impedance of .135 ohm at 10,000 Hz. When the .06 ohm resistor is inserted in the shunt cable, the impedance rises from the DC value of .062 ohm of the resistor to about .165 ohm at 10,000 Hz. To help relate these values to an actual train shunt, the actual static shunting resistance of one axle of a rapid transit car on shiny rail and of a two-axle truck of this same car on shiny rail is shown. All of these rail-to-rail shunting devices show an increasing impedance with frequency, indicating they all incorporate some series inductance.

Note that the previous discussions indicated shunts of .06 ohm and .001 ohm. Take a look at 3000 Hz. The shorted shunt strap does not have an impedance of .001, but rather .04 ohm while the shunt cable with the .06 ohm resistor has an impedance of almost .08 ohm.

It appears some additional standard will have to be set up to indicate what the AAR standard .06 ohm shunt really is at audio frequencies, that is .06 ohm at the frequency the shunt is being used.

As a side note, 24 feet of #14 wire has been used in the past to represent a .06 ohm shunt on DC track circuits. This is still a satisfactory .06 ohm shunt for DC track circuits, but it should not be used under any circumstances as a .06 ohm shunt at audio frequencies, since it can have substantial inductance and, depending on its lay, could actually be any number of values of impedance up to 2 ohms in the audio frequency band.

Audio frequency track circuits generally have receive end voltages lower than DC and AC power frequency track circuits. As a result, while good shunting is obtained with audio frequency track circuits on well traveled tracks, poor shunting performance has been observed on little used sidings or branch lines. Increasing transmitter power level appears to improve shunting sensitivity, but this all indicates that more has to be known about shunting problems at audio frequencies before these problems can be successfully solved.

Much of the data so far discussed relates to 90 lb. rail. As rail sizes increase, the rail inductance decreases slightly, which has the effect of increasing maximum track circuit length, increasing inter-rail voltages, and increasing preshunt and extended shunt distances for similar conditions. As a rough approximation, maximum track circuit lengths can be expected to increase 10 to 15% when going from 90 lb. rail to 127 lb. rail.

Figure 12 is a summary of how the different audio frequency equipment design parameters affect track circuit operation and characteristics. The small star in each block indicates the desired direction of each effect but note that there always appears to be a conflict.

As audio frequency equipment track impedance is raised as indicated by the upward arrow, maximum track circuit length increases to a point and then decreases, the preshunt and extended shunt distance increases, shunting sensitivity increases, inter-rail voltage increases to a maximum and then decreases, immunity to ballast change decreases, and the repeat frequency distance increases. As the equipment frequency is increased, the maximum track circuit length decreases, the preshunt and extended shunt distance decreases, the vehicle shunting impedance increases, and the repeat frequency distance decreases. When the transmitter output level is increased, the maximum track circuit length may increase only if the receiver sensitivity was not sufficiently high, the signal to noise ratio increases, the inter-rail voltage increases, rusty rail shuntability increases, and interference to other communication equipment also increases.

Santa Fe cuts turn-around time

Improvements of up to 48 hours in turn-around time of freight cars in trans-continental service have been achieved by Santa Fe Railway through a new method of scheduling train departures, John S. Reed, chairman and chief executive officer, has announced.

"Improvements of this nature in car utilization and service have the effect of increasing our freight handling capacity," Reed said. "This becomes of vital importance when you consider the prospect of more freight being diverted to railroads as a result of fuel shortages, since the industry is already carrying the largest freight load in history," he noted.

Called RHF (Regular High Frequency) scheduling, the new service has been in experimental operation between Kansas City, Kan., and the West Coast since September 1973 and has recently been expanded to include traffic between Chicago and the West Coast, Reed said.

Faster terminal handling produces the improvements in turn-around time, as actual running time of the trains remains about the same.

Train II?

"A popular misconception is that the only way to improve railroad equipment utilization is through use of a yet-to-be-designed central computer of great cost and complexity that could direct movement of all cars," Reed said. "While accurate information about location and destination of freight cars is important to railroad managements, good information is of little use unless someone acts upon it. We feel the primary need today is to improve the physical handling given to those cars by shippers, consignees and railways themselves. Santa Fe's RHF scheduling is a notable self-help step in the direction which will expedite movement and improve utilization of both loaded and empty freight cars," he stated.

Scheduling

The new scheduling calls for departures from Kansas City every four hours around the clock for Los Angeles, plus two departures daily at 12-hour intervals for northern California, with similar eastbound schedules. Prior to this change most departures were during the evening and night, after normal close of business in most industries.

The Chicago-West Coast scheduling now includes three departures for southern California at intervals of about eight hours and two for northern California at approximately twelve hour intervals.

"Under this new arrangement traffic moves when it shows up, instead of waiting for an arbitrary departure time that may no longer be relevant to a shipper's needs," according to Reed. "An added benefit to both railroad and shipper is that our key terminals are kept much more fluid, since the departure area is emptied more often. Similarly, the work of employes involved in fueling, safety inspections, running maintenance and other tasks at points all along the railroad has been spread out in an orderly fashion across the day, instead of having much of it pile up in a relatively short period," he said.

When the experimental program began in September, it was anticipated that only through traffic would be handled on these trains. It quickly became evident, though, that traffic to and from intermediate yards could readily be accommodated by these trains without difficulties, thus extending the improved service to shippers in those areas. This made possible the elimination of a number of local trains and improvement to local service at the same time.

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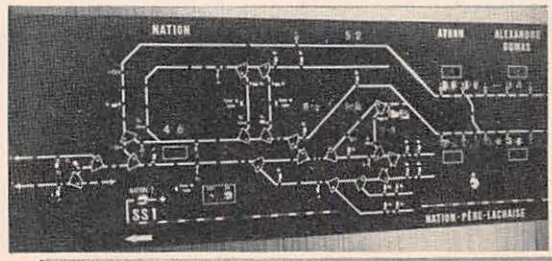

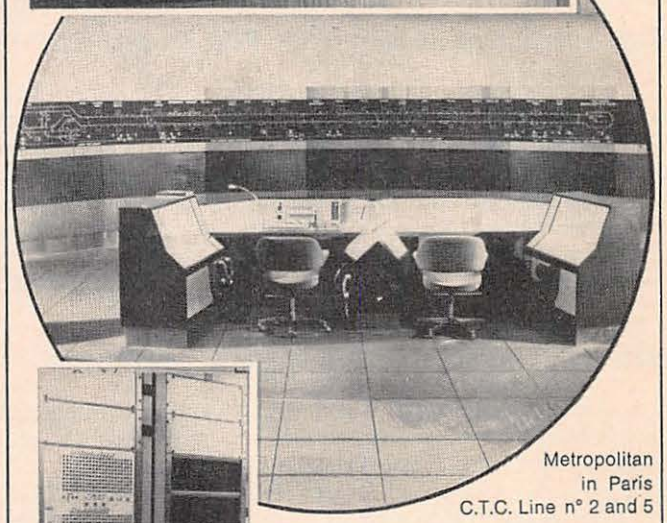

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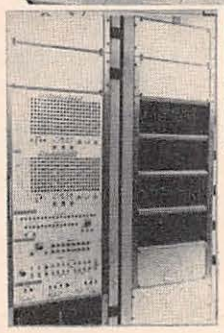

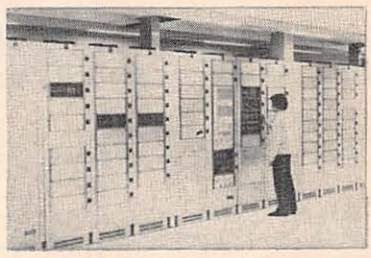

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RSC Product News

High speed tape reader is for PDP-8's and PDP-11's

A new, high-speed optical tape reader for use with Digital Equipment Corp.'s PDP-8 and PDP-11 series computers has been introduced by Computer Identics Corp. The OTR-120 (optical tape reader, 120 characters per second) is small, lightweight, portable, and ruggedized.

Options available include a field carrying case, paper tape bin, and for permanent applications, a rack mounting adaptor. The reader is supplied with its own printed circuit interface which plugs directly into the processor. *Computer Identics Corp.*

Circle 100 on Reader Service Card

New digital processor is modularly constructed

A new high-speed, program-controlled digital computer has been made available by Collins Radio Co. The C-8562A has been designed for use with the Collins C-8500 C-System.

The new processor contains up to 262,144 bytes of directly addressable memory, and provides powerful input/output comunication facilities for high, medium, and low-speed requirements.

The C-8562A-1 is modularly constructed and utilizes high density, multilayer planar boards, and medium and high-speed TTL integrated circuits.

When used in the Collins C-8500 C-System, the processor is said to perform all functions required in a single standalone processor system or in expandable multiprocessor applications.

Features of the new processor include high-speed Arithmetic Logic Control (ALCU) and memory units. Instructions and operands are accessed simultaneously by the ALCU and overlapped with instruction execution. Independent communication paths are provided to each of four 65K byte memory modules. *Collins Radio Co.*

Circle 101 on Reader Service Card

New disc option added to Model 340

An IBM 3740-compatible, dual flexible disk option has been added to Sycor's Model 340 intelligent communications terminal. The dual diskette option allows high-speed, random access to approximately half a million characters of disk storage and may be used with the two cassettes in the terminal.

The flexible disk capability can be used to record data, store and access formats and programs, and serve as an auxiliary input device for both large and small files. When used in combination with the cassettes, the dual diskette option provides high-volume batch storage.

The flexible disk recording unit consists of two disks capable of storing approximately 250K of data characters per disk. Each flexible Mylar disk contains 77 tracks of 26 sectors; each sector contains 128 bytes. *Sycor Inc.*

Circle 102 on Reader Service Card

New teleprinter operates at 120 CPS

Model 308 incremental teleprinter features line printer speed when high speed input is received, and character-by-character printing when input is received from the keyboard. The 120 character per second, 80 column 308 can operate at speeds of 100 to 9600 baud over communication lines.

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typed/printed data, a lighted column print position indicator denotes the next column to be printed. The 308 uses a 5 by 7 dot matrix pattern for character generation and prints an original plus four copies. Without the detachable keyboard, the 308 is a read-only terminal capable of accepting data from a CPU or other transmitting terminal. *Centronics Data Computer Corp.*

Circle 103 on Reader Service Card

Sweeper plug-in covers one thru four GHz

A new RF plug-in module which allows users of Systron-Donner microwave sweepers to cover the 1 to 4 GHz range with a single oscillator has been made available.

The new Model 5030 plug-in can provide a minimum power output of 20 mW into 50 ohms. Residual FM is said to be less than 50 db below maximum output.

The unit is designed to operate with Systron-Donner Model 5000A or 520 Sweepers. It may also be used with the company's Model 50520-1 Multiband Sweeper System for expansion of frequency coverage from the previous 2-18 GHz range to 1 to 18 GHz. *Systron-Donner Co.*

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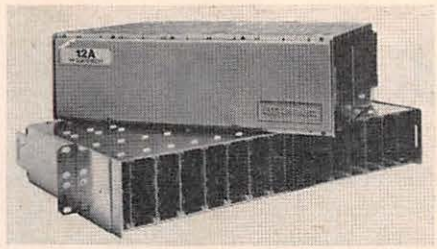

VF repeaters and solid-state signaling equipment available

A new line of VF repeaters and solid-state DX signaling equipment has been announced by GTE Lenkurt. Called type 12A, the equipment is said to offer expanded flexibility in voice-frequency amplification and signaling extension between carrier equipment and physical facilities, and over physical facilities alone. The all-modular equipment is designed for interoffice trunking, for private line and special service expansion, and for upgrading circuit performance.

A comprehensive line of 12A plug-in units includes two-wire to four-wire VF repeaters, four-wire to four-wire VF repeaters, two-wire to four-wire repeaters with DX1 or DX2 signaling, DX1/DX2 signaling units with or without repeat coils, and precision attenuators. VF repeaters are available with 600-ohm or 900 ohm impedance matching circuitry. *GTE Lenkurt Inc.*

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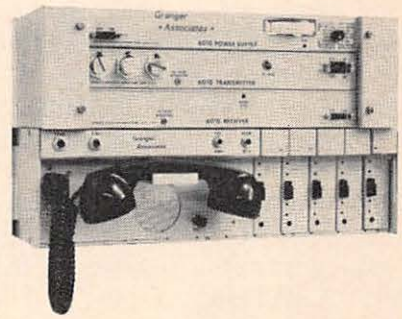

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Editor's Corner

Imagination stimuli

The Fourth International Symposium on Railroad Cybernetics will hopefully bring forth a better awareness of computer capabilities and applications for those who are behind in the virtually limitless uses of this growing field. Unresolved problems and opportunities for further progress will be discussed at the Symposium. Sixty three papers covering the aspects of the theme of the Symposium have been prepared by experts from the members of the three sponsors—AAR, UIC and IRCA.

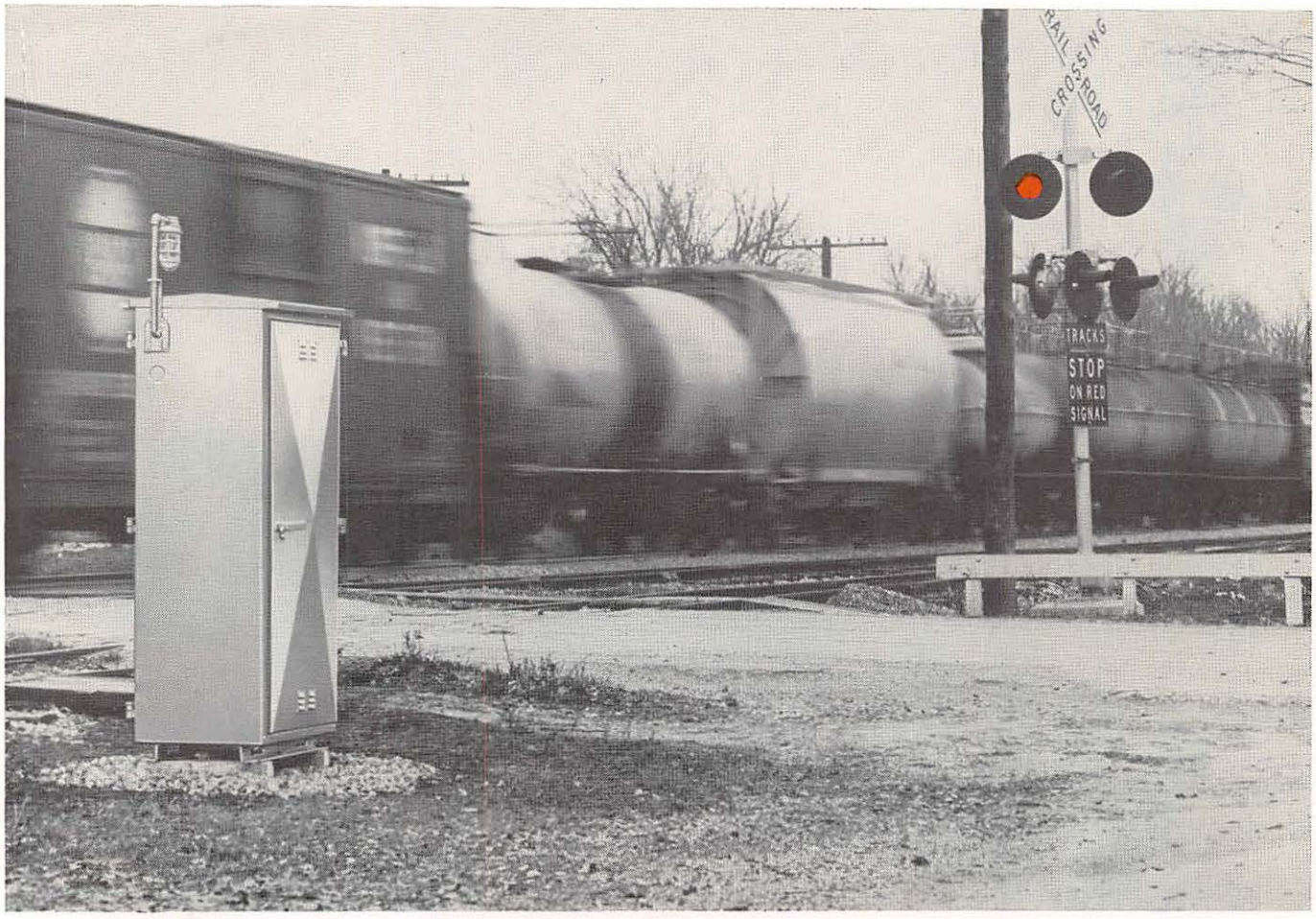
How efficiently has management been able to apply cybernetics? Some of today's railroad computers are crammed with huge amounts of useless and sometimes repetitive information. One approach for planning a system has been to build for the future—to over-build. While this may be called good foresight, one has to keep in mind the basic needs of the immediate application. Other railroads have computer systems capable of doing much more than is presently assigned to them. The 1974 Symposium should at least stimulate new thinking and expose fresh applications of cybernetics.

Will the delegates go home feeling as though they have gained useful knowledge and new wisdom? Not to compare the two, but what are some comments about the Third International Symposium held in Japan during 1970? Seaboard Coast Line Chairman and Chief Executive, W. Thomas Rice felt that the 1970 Symposium was most informative and served to emphasize the growing importance of computers in railroading. Since that time, SCL has made major progress in the innovative use of computers, particularly in the area of transportation and car control systems. Rice hopes that this year's Symposium will highlight the progress made by other roads in this most important area. Southern Pacific President B. F. Biaggini comments: "Of greatest benefit was an awareness that the problems of rail transportation management are basically the same regardless of the country or nation. With a problem similarity, the exchange of views, ideas and approaches of each of the individual representatives on areas where computerization can offer improvements certainly is beneficial." As to this year's Symposium, Biaggini goes on to say, "The difficulty, of course, with any large Symposium with limited time and a wide variety of subject matter is the inability to fully explore each subject in detail to understand the managerial motivation behind the computer decision that was made. It is my hope that the next Symposium will offer new insights into the reason cybernetics were applied to each area, as well as the technical application itself."

John S. Reed, chairman and chief executive of the Santa Fe, felt that perhaps many of the papers presented at the third Symposium were a bit too technical for management personnel to fully comprehend. He may have a good point! After all, railroad management has to be familiar with all aspects of its operation and really can't be expected to take over the design engineer's job. Reed goes on to say that because of early deadlines on submission of Symposium materials, some papers may be outdated and simply won't have the impact that would have been possible had the papers been presented on a more timely basis. The time-lag problem can't easily be resolved, because of the time needed to effectively plan the Symposium; it is one, nonetheless, which authors should keep in mind as they prepare their papers.

Although Reed does see room for improvement, he also says, "The main value of such a meeting is to enable railway men of various countries to exchange views. We frequently find our problems are about the same in different scenarios. One of my outstanding recollections was the discourse with the head of the Japanese National Railways complaining about his inability to manage his system properly. He described the political interference in his attempts to abandon unjustified and unprofitable service and to charge adequate fares—all of which were imposed on him under the guise of 'social welfare'. I thought at the time that the gentleman should be invited to our country to testify before a Congressional committee as to the effect of government interference in the efficiency of transport operations." Although this wasn't germane to the Symposium it was probably only one of many interesting conversations which could only take place at an International Symposium of this type.

Regardless of the problems which may need ironing out, most will agree that the Fourth Symposium will, at the very least, stimulate the imagination and open the door for new ideas. The opportunity for an exchange of views and problems should be beneficial.



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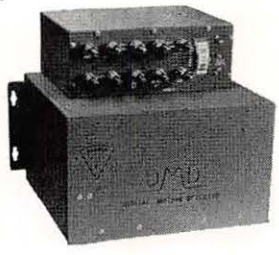

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